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THE TONGUE RIVER REHABILITATION PROJECT

Water Resources Division
Department of Natural Resources and Conservation
32 South Ewing
Helena, Montana 59620

OCTOBER 1981

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ABBREVIATIONS

cfs	cubic feet per second
DNRC	Department of Natural Resources and Conservation
EIS	environmental impact statement
EL	elevation
ft MSL	feet above mean sea level
FY	fiscal year
kWh	kilowatt-hour
MCA	Montana Codes Annotated
MW	megawatt
OMR	operation, maintenance and repair
PL	public law (federal)
PMF	probable maximum flood
TRWUA	Tongue River Water Users Association

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SUMMARY

In its present condition, the Tongue River Project would fail in a moderately large flood. The project's benefits would be lost. Downstream property would be destroyed. Most importantly, human life could be lost. In recognition of this danger, the Forty-Sixth Legislature directed the Department of Natural Resources and Conservation (DNRC) to study further aspects of the project in pursuit of measures to make it safe. This report documents the work done by DNRC in response to that mandate.

RECOMMENDATION

DNRC recommends that the present project's embankment be raised, the reservoir capacity increased, and the spillway enlarged as a joint state/federal/Northern Cheyenne Tribe project. This would make the project safe, increase the project's benefits, provide a vehicle to resolve Indian/non-Indian water rights conflicts, and be the least-cost alternative for the state.

PROJECT OBJECTIVES

In reaching this recommendation, DNRC evaluated five alternatives against the following four criteria:

1. The unsafe condition of the present project must be corrected;
2. Present project benefits (agricultural water supply, flood control, recreation and others) should be maintained and, if possible, increased;
3. The conflict over Indian/non-Indian water rights on the Tongue River should be resolved; and
4. While satisfying the other objectives, the alternative taken should be the least-cost alternative to the State of Montana.

Correcting the Unsafe Condition

Failure of the present Tongue River Project is not an unlikely event. In fact, if operated at full capacity, the project has a 13.8 percent probability of failing in the next 10 years. Flood routing studies indicate that downstream ranches and the communities of Birney and Ashland would suffer significant damage. A large amount of property would be destroyed and lives would most likely be lost. The high probability of failure combined with the large potential for property damage and loss of life mandate that the project be made safe.

Modern dam safety standards indicate that projects similar to the one on the Tongue River be large enough to safely pass the probable maximum flood (PMF), that is, the stream flow that would occur under the most severe combination of extreme weather and watershed conditions reasonably possible for the area. The PMF at the Tongue River Project may be as high as 400,000 cubic feet per second (cfs). Building a spillway to safely pass this large flow represents a major cost of each construction alternative. Breaching the dam would eliminate the danger of the project failing, but it would also eliminate the project's benefits.

Maintaining or Increasing Benefits

The present reservoir's 68,000 acre-foot capacity currently provides a firm annual yield of 40,000 acre-feet, which is primarily used to irrigate 18,500 acres of land. The Bureau of Indian Affairs purchases 7,500 acre-feet of water for use on the Northern Cheyenne Indian Reservation. The US Fish and Wildlife Service purchases stored water for its fish hatchery near Miles City. Until recently, the Montana Power Company held an option on 3,250 acre-feet* and the Decker Coal Company currently purchases 175 acre-feet for industrial use. In addition, the reservoir stores spring run-off that would otherwise cause downstream flood damage. The reservoir is a prime flat-water recreation area for local residents in Montana and Wyoming. Downstream flows, stabilized by the project, provide excellent fish habitat. In short, the Tongue River Project is an essential part of life in southeastern Montana and should be maintained. Many benefits of the project could be increased if additional water storage were provided.

The Tongue River's flows are large enough to allow considerably more water development and there is interest in the area for increasing the project's benefits. The Board of Natural Resources and Conservation allocated water in the Tongue River for irrigation in the Big Horn, Rosebud and North Custer conservation districts and the Department of State Lands as part of a reservation of Tongue River water for a larger storage project. The board also has reserved water for instream flows. Besides these uses, the area has potential for a coal-related industrial water market.

Resolving Indian Water Rights

The natural flow of the Tongue River cannot fully supply both the reserved water rights claimed by the Northern Cheyenne Tribe and the water rights perfected by non-Indians through beneficial use and appropriation under Montana water law. In fact, litigation to quantify the Northern Cheyenne Tribe's rights is on-going and is expected to be lengthy and costly. The water rights issue presents both a problem and an opportunity. On one hand, it is apparent that an enlarged project cannot be built unless water rights are available to fulfill the purposes of the project and, on the other hand, an enlarged project may be the key to solving the water rights conflict by supplying adequate water supplies to all water users. The tribe has expressed interest in a water project that would amicably resolve the conflict outside the court room and benefit both the tribe and other users.

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*Although the Montana Power Company recently dropped its option on water stored in the Tongue River Reservoir, all financial calculations in this report included that revenue as part of current industrial revenue.

Least-Cost Alternative

The state should only participate in a project when the first three project objectives can be satisfactorily achieved at minimum cost to the state.

The least-cost alternative appears to be through participation in a joint state/federal/Northern Cheyenne Tribe project which could encourage congress to fund a large portion of the project costs on behalf of the Northern Cheyenne Tribe. It is likely that the state would be required to contribute from 5 to 20 percent of construction costs plus the present project's assets, that the tribe would contribute its reserved water rights on the Tongue, and that congress would appropriate funds for the remaining portion of construction costs.

Congress may be interested in contributing to the project because the project would accomplish several federal policy objectives. These include:

1. eliminating the unsafe condition of the project;
2. federal-state cooperation in a project endorsed by the Yellowstone Level B Study;
3. development and utilization of hydropower; and
4. reaching a negotiated, rather than litigated, settlement of the Northern Cheyenne Tribe's reserved water rights.

PL 92-367 enacted the first step toward the national goal of eliminating unsafe dams that threaten public safety. Subsequent to the investigations pursuant to PL 92-367, the Tongue River Project was determined to be unsafe.

Although correcting the unsafe condition of the project is primarily the concern of the State of Montana as owner of the dam, the Northern Cheyenne Tribe and the federal government also have interest in making the project safe. Failure of the project would damage tribal lands and homes. Most likely, federal funding would be sought to alleviate tribal damages. Also, depending on the amount of damage in the downstream valley due to failure, it seems likely that the area would be declared a national disaster area and receive federal funding to assist in reclaiming the damage.

The Yellowstone Level B Study identified modification of the Tongue River Project as an approved regional project in order to provide irrigation water, hydropower, industrial water, and fish and wildlife benefits. Federal water policy calls for state-federal cooperation on such projects. Indications are that such projects would have higher priority on the federal project priorities list with a state-federal cost-sharing plan. A state cost share of 5 to 20 percent, which could be raised from the Water Development Program, appears to be sufficent to give special priority to the project. Although this system is not actually law, it appears to be the policy of the federal Office of Management and Budget.

The development and utilization of hydropower was identified as a federal objective in the National Energy Plan of April 29, 1977. The recommended project's hydroelectric facilities may benefit local residents and make a contribution toward national energy independence.

The settlement of Indian/non-Indian water rights, while being a state objective, is also a federal objective as identified in the Water Policy Message of June 6, 1978. As pointed out earlier, the recommended project may be a vehicle for achieving that goal in the Tongue River basin.

PROJECT ALTERNATIVES

DNRC evaluated five basic alternatives that meet to some degree the project objectives. These alternatives are:

1. Repairing the existing project by building a larger spillway;
2. Enlarging the reservoir capacity, and building a larger spillway at the existing site;
3. Breaching the dam;
4. Building a larger project at the Post Creek site;
5. Building a larger project at the high Tongue dam site.

Several of these alternatives have been considered with and without coal-mining options. These alternatives are explained in Chapter 3, "Alternative Solutions".

While considering the alternatives, DNRC investigated financing schemes to pay for the project. These are explained in Chapter 5, "Financing Methods".

RECOMMENDED PROJECT AND IMPLEMENTATION

DNRC recommends that the present embankment be raised, the reservoir capacity increased, and the spillway enlarged as a joint state/federal/Northern Cheyenne Tribe project. This project would eliminate the danger to life and property. It would preserve and increase the present Tongue River Project's benefits. In DNRC's opinion, it would produce a sufficient firm annual yield to supply most, if not all, current and future water needs in the area, thereby providing a mechanism that may resolve the Indian/non-Indian water rights conflict. Finally, it would be the least-cost alternative for the state since, through participation by the Northern Cheyenne Tribe and the federal government, congress would probably appropriate most of the project's cost (approximately $80 million).

The federal government has expressed interest in cooperating with the State of Montana in building and funding the Tongue River Project. After looking at other funding options, the DNRC recommends this joint federal-state financing plan.

DNRC recommends the joint project not only because of interest by federal agencies but because of the project's inability to pay for itself. This report considers the possibility of paying for the project with coal mining revenues. However, this and other project revenues (mainly water and hydropower sales) would not cover the cost of planning, designing, constructing, and managing the Tongue River Project. Revenues are covered in Chapter 4, "Comparison of Alternatives".

Reservoir operation would be managed by a contractual agreement between the project sponsors. A water rights compact, indicating the allocation of Tongue River water between Indian and non-Indian water users, would have to be ratified by the Montana legislature, the tribal council and congress.

Project costs would be paid by congressional appropriation, with the state possibly sharing the cost and contributing project assets. This alternative coincides with federal water policy which calls for, whenever possible,

state-federal cooperation, elimination of unsafe dams, and negotiation rather than litigation with Indian tribes. The state's share of the costs would be raised by issuing bonds by coal severance taxes.

If each phase of the project's preconstruction and construction schedule proceeded as planned, the project could be in place as early as October, 1990. Table 24, page 84, shows the schedule of activities for the project.

In order to implement the recommended alternative, DNRC requested and received $430,000 from the 1981-82 biennium to complete the following tasks:

1. Participate with the federal government and the Northern Cheyenne Tribe in federally-funded feasibility studies which are necessary to obtain congressional appropriation for the project.
2. Cooperate with the Northern Cheyenne Tribe and the Reserved Water Rights Compact Commission to reach a negotiated settlement of the tribe's water right in conjunction with the project.
3. Develop, maintain, and advertise an emergency warning and downstream evacuation plan for residents living below the Tóngue River Project.

Table 25, page 88, summarizes the budget necessary to carry out these tasks and the tasks are detailed in Chapter 6, "Recommended Project".

1. INTRODUCTION

In 1940, the State of Montana completed construction of the Tongue River Project, creating a major storage reservoir in water-poor southeastern Montana about 10 miles north of the Montana-Wyoming border (figure 1). Although the State of Montana built the Tongue River Project to provide a reliable source of irrigation water, recreation has also become an important use of the reservoir.

The Montana Water Conservation Board (which was the predecessor of the present Board of Natural Resources and Conservation) originally financed the Tongue River Project with the help of a grant and loan from the US Public Works Administration. Although the State of Montana owns the project, an agreement transfers the operation to the Tongue River Water Users Association (TRWUA).

The Department of Natural Resources and Conservation (DNRC) has suspected for a number of years that the Tongue River Project's spillway had design and possibly structural deficiencies. This initial indication came from a study by the Bechtel Corporation (1969), indicating that the design flood was much larger than the project was capable of handling. Since then, several investigations have confirmed Bechtel's findings. Furthermore, a relatively small flood in May 1978 damaged the ailing spillway, emphasizing the urgency of correcting the unsafe situation posed by the Tongue River Project. The problem is, quite simply, that a large flood flowing through the undersized spillway would cause the project to fail, and send a wall of water down the Tongue River valley.

DNRC has undertaken two major repair projects on the spillway, including a $1 million overhaul after the May 1978 flood. The repair projects have alleviated the structural deficiencies of the spillway but, even in good repair, the spillway is underdesigned and dangerously small.

The US Army Corps of Engineers recommends the PMF which occurs under the most severe yet reasonably possible meteorological and hydrological conditions in the study area, as the design flood for a project. A preliminary calculation of the PMF for the basin above the Tongue River Project estimates the PMF at 400,000 cfs, but the spillway is designed theoretically to handle only 98,000 cfs. The May 1978 flood (19,000 cfs) proved that the spillway actually has a much smaller capacity. After the reservoir filled, about 7,000 cfs passed over the spillway. The spillway barely withstood this overflow, and considerable damage resulted. Thus, a spillway theoretically having a capacity to pass 98,000 cfs was severely damaged while passing only 7,000 cfs resulting from a flood of about 19,000 cfs, compared to a PMF of 400,000 cfs.

A PMF occurs somewhere in the world every year. Floods approaching this magnitude have occurred along the eastern slopes of the northern Rockies--in

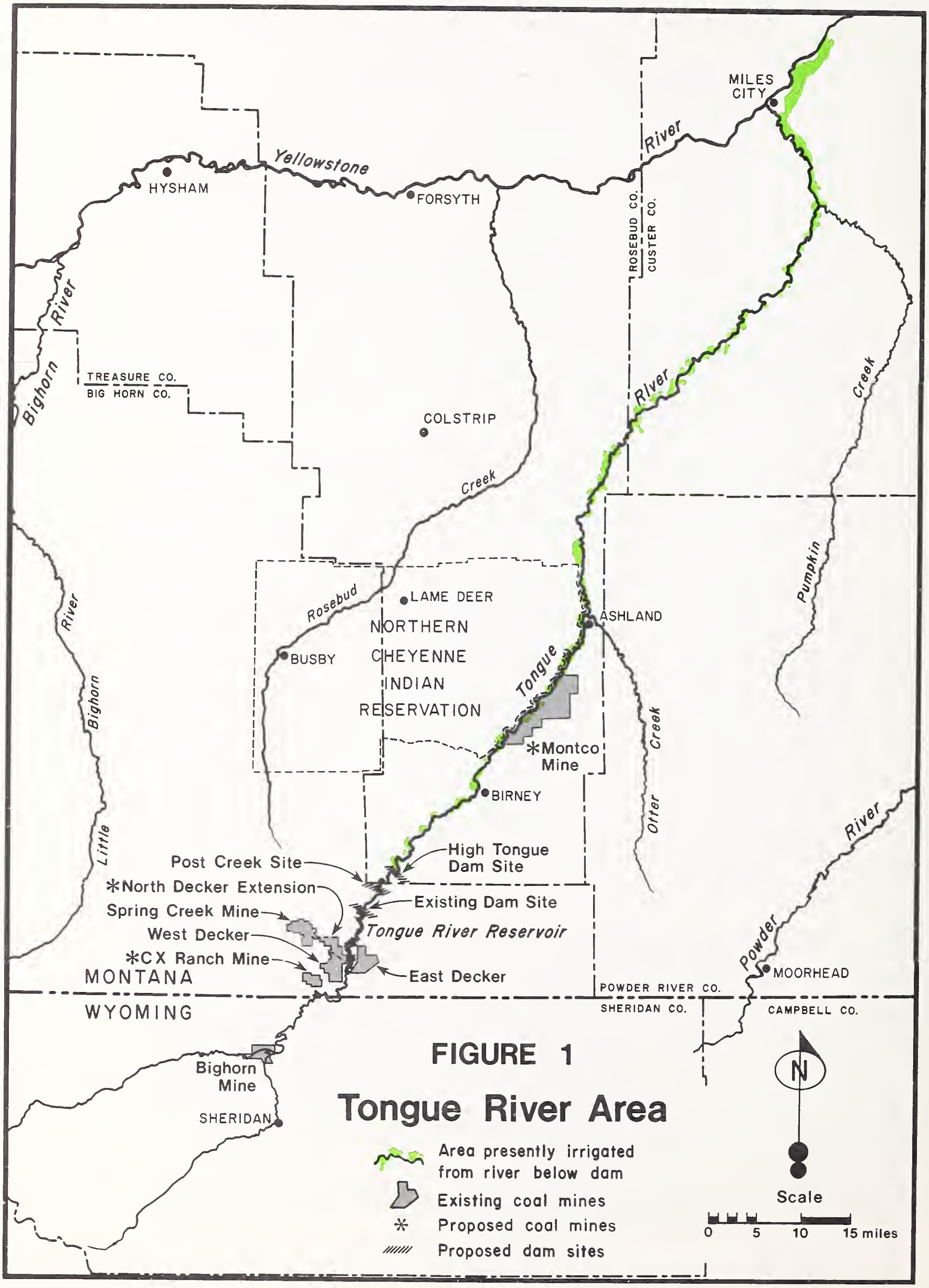

FIGURE 1

Tongue River Area

Montana's Glacier National Park in 1964 and in Colorado's Big Thompson Canyon in 1978. In 1923, the Tongue River basin reportedly had a 60,000-cfs flood, calculated as a 400-year event. The May, 1978 flood was only a 40-year event.

The probability of having major floods in the Tongue River is actually quite high. (Refer to table 1.) For example, the probability in any 20-year period of the Tongue having a 30,000-cfs flood (the Tongue's 100-year flood) is 18 percent, and a 40,000-cfs flood (the Tongue's 200-year flood) is 10 percent. This means the Tongue River basin has a one in ten chance of having a 40,000-cfs flood in the next 20 years. The 200-year flood, although one-tenth the size of the PMF (400,000 cfs), would be sufficient to cause failure.

Table 1. Probabilities of flood events for various periods of time at the Tongue River Dam.

Number of Years	Probability of a 30,000-cfs Flood (100-year frequency)	Probability of a 35,500-cfs Flood (150-year frequency)	Probability of a 40,000-cfs Flood (200-year frequency)
1	.01	.01	.005
2	.02	.01	.01
10	.10	.06	.05
20	.18	.13	.10
30	.26	.18	.14
40	.33	.23	.18
50	.39	.28	.22
60	.45	.33	.26
70	.51	.37	.30
80	.55	.41	.33
90	.60	.45	.36
100	.63	.49	.39

The present spillway might handle a 30,000-cfs routed flood (which occurs on the Tongue River at a frequency of once in 100 years) but a 40,000 cfs flood (which on the Tongue has a 200-year frequency) would most likely wash the project out. With the spillway gone, a channel would quickly erode, sending the contents of the reservoir downstream as a destructive wall of water.

The State of Montana, as owner of the Tongue River Dam, is responsible for hazardous conditions caused by the dam. The likelihood of extensive property damage and loss of life further emphasizes the need to solve the safety problem.

Recognizing this need, the Forty-Sixth Legislature mandated further studies of the Tongue River Project. Before deciding on a recommended solution, DNRC considered alternatives involving improvement of the existing dam, building a new dam, or breaching the existing dam.

Finding a way to correct the unsafe condition of the Tongue River Project was only one of the goals of the Tongue River Project, although it was the most pressing. Other goals included:

-- Maintaining and, if possible, increasing present project benefits, including agricultural water supply, flood control, recreation and other benefits;

-- Resolving the conflict over Indian/non-Indian water rights on the Tongue River; and
-- While satisfying the other objectives, taking the least-cost alternative for the State of Montana.

In the study DNRC used a team approach that combined private sector expertise with that of DNRC personnel and employees from federal and other state agencies. This report primarily comes from the research efforts of team members. The team identified the following as critical areas for study: (1) economics and financing, (2) engineering and construction, (3) coal mining, (4) environment and social conditions, and (5) legal issues. Some of the material provided by the team members can be found in The Appendixes to the Tongue River Rehabilitation Project under a separate cover.

2. BACKGROUND

A. PROJECT DESCRIPTION

1. Existing Project

The Tongue River flows 100 miles or so from its head waters in Wyoming's Bighorn Mountains to Montana's Tongue River Project which is located about 10 miles north of the Wyoming border and 189 river miles southwest of the Tongue's mouth on the Yellowstone at Miles City. The Tongue River Project, owned by the State of Montana, was completed in 1940 and was administered by the Montana Water Conservation Board until 1972, when DNRC inherited the responsibility.

The Tongue River Reservoir, which is impounded by the 91-foot-high dam, occupies a section of the Tongue River valley that is wider and flatter than the sections immediately above and below the reservoir. The Fort Union Formation dominates the surface geology. This formation consists of soft, silty sandstone, clay shales and coal beds. Porcellanite and clinker, caused by burned coal deposits, have formed in adjacent shale beds. The gullies that have cut into the valley have given the reservoir a ragged shoreline.

At maximum capacity, the reservoir extends 7.8 miles, is one mile across at its widest point, has an average depth of 20 feet and holds 69,439 acre-feet of water. Although the project could produce a larger firm annual yield, it is operated at a lower level (due to the small spillway and for enhanced flood control) and produces only 40,000 acre-feet. On the average, 339,100 acre-feet flows out of the reservoir each year.

In an arid region, such as the Tongue River basin, where annual precipitation averages from only 11 to 16 inches, a firm water supply is a welcome commodity. The Tongue River Project provides a reliable source of water on a river that would otherwise go dry from time to time--a major benefit for the farmers and ranchers in the Tongue River valley below the dam. Agriculture uses most of the water stored in the reservoir, about 36,000 acre-feet, 7,500 acre-feet of which goes to the Northern Cheyenne Tribe. Decker Coal Company and the new Spring Creek coal mine, the only current industrial users, use 175 acre-feet and 750 acre-feet from the reservoir, respectively. Until recently, the Montana Power Company had held an option for 3,250 acre-feet.* The federal fish hatchery near Miles City uses 650 acre-feet of water, and 50 acre-feet is used by the St. Labre Mission (domestic supply) near Ashland.

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* Although the Montana Power Company recently terminated its option on water from the Tongue River Reservoir, certain aspects of this report still assume involvement of the Montana Power Company (e.g. revenue).

In addition to supplying water for the aforementioned uses, the Tongue River Project has created significant opportunity for water-based outdoor recreation, a rarity in southeastern Montana. Anglers, boaters, and other recreationists use the reservoir and river heavily. The reservoir has also stabilized flows and improved fish and wildlife habitat downstream, further enhancing the recreational potential of the area. The project has benefited aquatic wildlife, such as waterfowl.

Besides supplying water, recreation and habitat, the Tongue River Project provides valuable flood control to landowners downstream from the dam and to the communities of Birney, Ashland and Miles City. When drawn down below capacity, the reservoir can help catch a destructive flood. This happened in May, 1978, when the reservoir experienced a peak inflow of 19,000 cfs, but only 7,000 cfs passed over the spillway.

2. Regional Economy

Until recently, the economy of the region surrounding the Tongue River Project has relied almost exclusively on ranching and farming. Although coal mining and recreation now contribute to the regional economy, agriculture still dominates.

Three active strip mines exist near the Tongue River Project--Decker West, Decker East, and Spring Creek. These mines, which are among the largest in the world, with their associated facilities and residential and commercial development, have begun to contribute to the economy of southeastern Montana. Today, however, most coal mine employees commute from Sheridan, Wyoming, with some management personnel maintaining offices there. Consequently, while the severance, resource indemnity, and gross proceeds coal taxes benefit Montana and Big Horn County, much of the economic benefits but, also, the social costs go to Wyoming.

Nonetheless, local businesses still benefit from the exploration and development of the area's enormous coal resource, and this economic impact will most likely become more significant in the future. For example, a new, 3,000-resident community of Spring Creek in Big Horn County, Montana, has been proposed on the west shore of the reservoir to serve the mine employees from nearby coal mines.

In addition, several energy companies and utilities have proposed a Tongue River Railroad from the proposed Montco mine near Birney north to Miles City to connect with the east-west Milwaukee rail line. If built, this railroad will undoubtedly promote the development of several mines in the Tongue River valley, resulting in an enhanced economic impact on southeastern Montana.

These energy-related developments may create new demands for industrial water, with the Tongue River Project the most readily available source. Although no synthetic fuel plants have been proposed for the Tongue River valley, such development could dramatically increase water demand. Mining developments, on the other hand, use smaller amounts of water.

Although current state law prohibits using Montana water to export coal in the form of slurry, interest in coal slurry persists. If this use of water were to be legalized, demand for industrial water would further increase.

An enlarged reservoir will likely have the capacity to provide industrial water. That would be viewed differently by individuals who either favor or oppose industrial development in the area.

B. WATER RIGHT ISSUES

The doctrine of prior appropriation is the basis of Montana water law and the key to understanding this doctrine is the idea of priority date. Every water right has a priority date which corresponds to a date in history. Prior to the Water Use Act of 1973, priority dates were established either on the date the water was first diverted and put to beneficial use, on the date that a claim was posted and registered (if the optional statutory scheme was followed and the water was later put to beneficial use with due diligence), or, in the case of reserved water rights, on the date Indian treaties were signed and Indian reservations established or the date federal land was withdrawn. In practice, however, the doctrine of prior appropriation means that during times of short water supply, a person holding a water right with a recent priority date (that is, a junior appropriator holding a junior right) must stop drawing water so that persons holding water rights with earlier priority dates (that is senior appropriators holding senior rights) can get the water to which they have a right.

1. Tongue River Decree

A 1914 court decree allocated 419.45 cfs among the claimants to water on the Tongue River. Most of the water under the decree is used during the irrigation season. Table 2 lists the rights in that decree. Some of these rights are no longer in use because the lands appurtenant to them have been inundated by the reservoir. It is of interest that the decree gives the Northern Cheyenne Indian Reservation right to 30 cfs, since the water rights of the Northern Cheyenne Tribe have a significant impact on the Tongue River Project.

2. Reserved Rights of the Northern Cheyenne Tribe

An important part of understanding the Northern Cheyenne Tribe's right to the Tongue River is understanding the Winters doctrine. The Winters doctrine came as a result of Winters vs. United States, 207 U.S. 564. In this case, the US Supreme Court ruled that when the federal government reserved lands from the public domain for an Indian reservation, it reserved rights to enough unappropriated water for the purposes of the reservation. The priority date of such reserved rights is the date the lands were reserved. In the case of the Northern Cheyenne Indian Reservation, 1900 would be the priority date for the claim on the Tongue River. The tribe has arguments that the use of Indian reserved rights is not limited to uses contemplated at the time the land was reserved. Additionally, there are arguments that a tribe on a reservation is not limited to the technology of the time that the land was reserved in using the water.

The Winters doctrine leaves uncertainty about how much water remains available for appropriation in the Tongue River. The 30 cfs granted to the Northern Cheyenne Indian Reservation in the 1914 decree might be only a part of the tribe's reserved rights. The Northern Cheyenne Tribe believes that it has the senior right to as much water as it needs, now and in the future. The reserved rights of the Northern Cheyenne Tribe are undetermined, although they may be large.

The questions surrounding the Northern Cheyenne Tribe's reserved water rights are being litigated but so far it has not even been determined whether the case will be heard in federal or state court. The state of the law now is

Table 2. 1914 Tongue River decree.

Water Right Holder*	Priority Date	Amount of Water** (Miner's Inches)	(cfs)
Marcus Nance	July 6, 1886	419.55	10.49
Tongue and Yellowstone	August 9, 1886	7,500.00	187.50
Brewster-Arnold Cattle Company	April 19, 1890	159.90	4.00
Canyon Creek Cattle Company	July 14, 1891	359.40	8.98
Canyon Creek Cattle Company	June 1, 1894	257.30	6.43
F. McQuinton, Don Mobley	June 1, 1895	941.20	23.53
Claude Welch	June 15, 1895	133.84	3.35
Canyon Creek Cattle Company	October 27, 1896	59.15	1.48
Canyon Creek Cattle Company	October 27, 1896	75.15	1.88
Stuart Petrie	October 27, 1896	26.50	0.66
Stuart Petrie	October 27, 1896	25.50	0.64
Ball Ranch Company	January 27, 1897	676.45	16.91
Ball Ranch Company	January 27, 1897	49.70	1.24
R.S. Hasford	October 1, 1897	83.69	2.09
Shreve, B.F. Located on upper end of reservoir site--canal all in reservoir site.	July 1, 1898	182.35	4.56
Lee, Erasmus R. Mostly all in reservoir site--R.A. Lee, son, pumping downstream	October 1, 1898	45.65	1.14
Canyon Creek Cattle Company	May 1, 1899	24.50	0.61
Brown Cattle Company	May 1, 1899	78.86	1.97
Brown, J.T. Land & Cattle Company	September 22, 1899	533.85	13.35
Brewster-Arnold Cattle Company	September 22, 1899	187.50	4.69
Brewster-Arnold Cattle Company	September 22, 1899	15.30	0.38
Brewster-Arnold Cattle Company	September 22, 1899	26.85	0.67
Sig Thompson	June 1, 1900	81.13	2.03
S-H Ranch (Nefsy)	December 19, 1900	1,781.00	44.52
Knoblock, Jack	January 29, 1901	113.20	2.83
Brown, J.T. Land & Cattle Company	April 4, 1902	276.30	6.91
Glen Viall	December 10, 1902	157.10	3.93
Glynn Pugh	December 10, 1902	395.00	9.87
Ball Ranch Company	December 17, 1908	314.45	7.86
Eddy, J.R. (Sup't Northern Cheyenne Indian Reservation)	March 24, 1909	1,200.00	30.00
R.L. & D. Rhea	November 22, 1910	597.90	14.95
TOTALS		16,778.27	419.45

* The names given in this table are those of the persons to whom the decree was originally given. Some rights may have been sold, devised, or inherited.

** The decree was originally given in miner's inches. Since that time, the legal measurement for flows in Montana has changed to cfs. By Montana law, 40 miner's inches equals one cfs.

Note: Some water rights appurtenant to lands inundated by the Tongue River Project are no longer in use.

that reserved water rights can be adjudicated in state court as long as the proceeding is a court proceeding and not an administrative one. The proceeding must also be comprehensive (that is, it must include all claimants in the watershed).

A decision on this matter could come as a part of the solution to the problem of the Tongue River Project. The Reserved Water Rights Compact Commission, established to negotiate with Montana Indian tribes, is negotiating with the Northern Cheyenne Tribe regarding water rights in the Tongue River.

Actually the fate of the Tongue River Project may depend on negotiations with the Northern Cheyenne Tribe. Unless the Northern Cheyenne Tribe agrees to participate and allows the water under its water right to be stored, a new enlarged reservoir project would most likely be hindered by water right problems. If, however, the Northern Cheyenne Tribe does agree to participate by allowing the water under its right to be stored in a new enlarged reservoir and contributes financially (most likely through the federal government), the success of the project would be enhanced. The implementation problems associated with the Northern Cheyenne Tribe's reserved right, of course, would only occur when the tribe begins to actually use the water. This eventuality must be assumed, although the tribe has never even used all of the 7,500 acre-feet of water it has purchased from the present reservoir.

3. Yellowstone River Compact

The Yellowstone River Compact, adopted December 8, 1950, allocates the water that was unused and unappropriated as of January 1, 1950, in the Yellowstone basin, which includes the Tongue River, to the signatory states of Montana, Wyoming and North Dakota. All three states and congress have ratified the compact.

The compact recognizes appropriative rights to beneficial use of Tongue River water existing as of January 1, 1950 and allocates to Montana and Wyoming supplemental water necessary to fully provide for such rights. The compact also purports not to adversely affect the reserved rights of Indian tribes or the federal government.

The remainder of the unused and unappropriated water as of January 1, 1950, in the Tongue River is allocated 60 percent to Montana and 40 percent to Wyoming. The Yellowstone River Compact also sets up a mechanism for building a reservoir that extends from one state to the other. In considering alternatives to the Tongue River Project, however, DNRC decided not to employ this mechanism of the compact and involve the State of Wyoming. Accordingly, DNRC only considered alternatives that would back water to the Wyoming border.

4. State Water Reservations

The Montana Constitution, as ratified in 1972, recognizes and confirms existing water rights for beneficial uses and directs the legislature to provide a system of centralized records for all water rights. That constitutional directive was initiated in the Water Use Act of 1973, and subsequent amendment.

Under the 1973 law, government agencies may apply to reserve water for existing or future beneficial uses. In December 1978, DNRC was granted a total of 384,000 acre-feet from the Tongue River in order to produce a 100,000-acre-foot firm annual yield under the statutory provision for water reservations. This reserved water was intended to be developed in an enlarged Tongue River Project.

In issuing the reservation, the Board of Natural Resources and Conservation instructed DNRC to make 20,900 acre-feet per year available from the project to the Department of State Lands and the Big Horn, Rosebud and Custer conservation districts. Additionally, the Department of Fish, Wildlife and Parks was granted a 75-cfs reservation for instream flow in the Tongue River.

5. Project Storage Rights and Contracts

Water users often prefer storage rights or contracts for use of storage rights over diversion rights. A storage right is likely to be fulfilled, whereas a diversion right depends in part on the amount of water available in the stream. At low flows, the holder of a diversion right may end up without water because the water is not physically available. The holder of a storage right or contract, however, can order the release of stored water from the reservoir under the storage right or contract.

Most Tongue River water users hold storage contracts made possible by the Tongue River Project in addition to diversion rights. These storage contracts, however, could become less valuable, as would DNRC's storage right for the Tongue River Project and reservation, if the Northern Cheyenne Tribe were to receive a large quantity of water in a settlement as a result of negotiations by the Reserved Water Rights Compact Commission, a court adjudication, or through an act of congress.

Beginning in 1937, DNRC contracted with water users to provide irrigation water from the Tongue River Project. There are four types of water contracts presently used in connection with the Tongue River Project. They include a water marketing contract, water purchase contracts, a contract directly between DNRC and the ultimate user, and a water delivery contract.

The water marketing contract, signed July 1, 1937, between the State of Montana and TRWUA obligated the state (subsequently through DNRC) to furnish ". . . the total available yield of stored water from the project," then estimated at 32,000 acre-feet annually. It also turned the responsibility for project operation over to TRWUA. TRWUA is obligated to pay the full sum due under the water marketing contract even if water is not available due to a water shortage. On March 13, 1969, the original water marketing contract was amended, supplemented and clarified providing TRWUA with three years in which to market up to 40,000 acre-feet annually to agricultural users. According to the amended contract, TRWUA has a permanent right to the amount of water that was marketed within the three-year period. Counted against the 40,000 acre-feet was the water already obligated to agricultural users and other specified users under water purchase contracts, which are discussed below. A total of 35,825 acre-feet per year has been obligated in this manner.

The water allocated to TRWUA is marketed to the ultimate user through water purchase contracts. These contracts are three-party agreements between the State of Montana, which owns the project and administers it through DNRC, TRWUA, which operates the project, and the water user. Under such a contract, TRWUA agrees to furnish a specific amount of water annually to the water user.

In the third type of water contract, the State of Montana (through DNRC) contracted directly with the ultimate water user. DNRC entered into such a contract with the Montana Power Company, March 1, 1972, with a term of 40 years with options to extend for two 10-year periods. The contract with Montana Power Company involved an option on 3,250 acre-feet per year. Through the contract,

the Montana Power Company reserved water from the reservoir. If, however, DNRC would find another buyer for the water reserved by the Montana Power Company, the company would have had either to begin using the water or pay DNRC for the water as if the company were actually using the water.

In the fourth type of contract, the water delivery contract, the State of Montana (through DNRC) and TRWUA contracted with the Tongue and Yellowstone Irrigation District to deliver water from the reservoir to the ultimate users. The irrigation district agreed to act as the agent of TRWUA and DNRC for the distribution of water to users in and out of the irrigation district. The contract allows the irrigation district to charge users for its cost of carrying water.

C. OTHER LEGAL ISSUES

1. Dam Safety

Montana statutory law makes it clear that the State of Montana, as owner of the Tongue River Project, and DNRC, as its operator, must exercise reasonable care for persons and property downstream from the dam. Sections 85-15-101 and 85-15-102, MCA govern safe installation and use of reservoirs and dams. Section 85-15-304, MCA provides that any person violating such laws is punishable by a fine of not more than $500 or imprisonment for not more than six months, or both. If death results from the violation, the guilty person may be convicted of homicide.

Section 85-15-102, MCA, prescribes two procedures for determining the safe condition of an existing dam within the state. Under these procedures, DNRC may examine a dam on its own initiative or shall examine a dam upon complaint. As inspector and operator, DNRC has found the Tongue River Project unsafe under certain conditions due to an undersized spillway.

The potential extent of civil liability for damages resulting from project failure would depend on the number of persons injured or killed and the amount of property damage resulting from a project failure. The State of Montana could be liable if it was found to be negligent in its operation or maintenance of the project and if damage resulted from that negligence.

Following the constitutional amendment that abolished sovereign immunity for the State of Montana, the legislature, as allowed under the amendment, set up a payment schedule limiting liability to economic damages in the amount of $300,000 for each claimant and $1,000,000 for each occurrence. The State of Montana remains immune to noneconomic and punitive damages. A successful plaintiff, however, may petition the legislature for payment of noneconomic and economic damages in excess of the statutory limits.

Regardless of liability, the damage that occurs to the citizens as a result of a project failure would be the same. The liability issue is merely a question of how much of the damage expenses will be absorbed by those who suffer the damages and how much will be paid by the State of Montana as owner of the project.

2. Water Contracts

In the primary water marketing contract with TRWUA, the State of Montana agreed to use "all reasonable means to guard against water shortage," but was not liable for any damage, direct or indirect, arising from water shortages. This provision may affect the Tongue River Project because all alternatives (except breaching) involve a temporary water shortage created during construction. Breaching the dam would, of course, mean an enduring water shortage. The 1969 amendment to the water marketing contract provides TRWUA with a right to water from a "new project" but the amendment does not make any provision for water shortages due to construction or repair.

The standard, three-party, water-purchase contracts also require payment under all circumstances. If the State of Montana cannot provide an adequate amount of water from the original project, the purchaser is entitled to a proportionate amount of the available water. The standard contract makes no further provision for reduction of the amount of water available to the purchaser or for an increase in the per-acre-foot price of the water provided.

The water marketing contract with TRWUA, as amended, and the three-party, water-purchase contracts do not specifically address water shortages due to construction or repair. It is possible to read the contracts as requiring the State of Montana to provide water to the users under these contracts subject to penalty for breach of contract even though no water may be physically available due to construction or repair. On the other hand, the contracts may be read such that DNRC has no obligation to furnish water if water is not available due to shortages--even shortages caused by construction or repair--and, at the same time, the users may be required to make payments for water.

In the contracts issued directly to the ultimate user, such as the contract with the Montana Power Company, DNRC exonerates itself from any liability arising from damages, direct or indirect, caused by water shortage due to "drought or uncontrollable forces" which are defined to include "failure of facilities." Likewise, the water delivery contract does not guarantee the amount of water available.

In short, there are two problems involving construction-related water shortages and water contracts. First, none of the four types of contracts expressly permits DNRC to reduce the water furnished to the ultimate user if the project needs repair or must be breached. Only the contract between the State of Montana and the Montana Power Company contains language sufficient to reduce the water available. Second, the first two types of contracts require the water user to pay for water even if it is not available, such as during spillway reconstruction. These two problems present obstacles for the State of Montana in its attempts to eliminate hazardous conditions at the Tongue River Dam.

DNRC is studying possible solutions to both problems and will make recommendations accordingly. Also, current negotiations involving the State of Montana, southeastern Montana water users, the federal government, and Indian tribes may produce a solution.

One possibility under consideration by DNRC involves the termination of the original water contracts for water from the Tongue River Project with the concurrent negotiation of new contracts.

D. PREVIOUS INVESTIGATIONS

In 1967, the Montana legislature authorized the Montana Water Resources Board to study the Tongue River for the development of industrial water supplies. Subsequently, the Board contracted with the Bechtel Corporation for the engineering studies.

As its first step, Bechtel (1968) studied the relationship between firm annual yield, reservoir size, and available water supply, including federal reserved waters and water rights established in Montana and Wyoming and by the Yellowstone River Compact. After estimating the allocation and availability of water, Bechtel (1969) continued with the basic dam engineering study, investigating the feasibility of raising the existing dam and of constructing a high Tongue dam downstream from the present structure.

Because the existing site could store only about 140,000 acre-feet (producing 72,000 acre-foot firm annual yield) within Montana, Bechtel developed designs and cost estimates for the high Tongue dam which would store from 320,000 to 450,000 acre-feet. This essentially fully develops Montana's share of the Tongue River under the Yellowstone River Compact and produces a 100,000- to 120,000-acre-foot firm annual yield.

In 1976, the Engineering Bureau of DNRC prepared a report that reviewed the current reservoir operation and the condition of the structures. The engineers found that the outlet structure needed repair and that a large part of the spillway floor had deteriorated and probably should be replaced. In addition, the deterioration raised questions about the stability of the spillway foundation. For these reasons, the reservoir has since been operated at a lower level to avoid using the spillway.

DNRC's Engineering Bureau's report reviewed the 1969 Bechtel Basic Design Report and a report prepared for the State of Wyoming by the Pacific Power and Light Company (1973). This latter report listed possible dam sites on the Tongue River drainage in Wyoming. In addition, the Engineering Bureau report examined possible conflicts between the high Tongue dam and coal mining. The report concluded that the high Tongue dam and enlarged reservoir would present a minimal hardship on mining.

Also in 1976, DNRC authorized (in response to the desires of the Forty-Fourth Montana Legislature) R.C. Harlan and Associates to study modifying the existing dam. Harlan's report presented feasible modification designs and cost estimates for the existing Tongue River Dam. Harlan presented five alternatives for modifying the existing dam and an updated cost for stage one of the high Tongue dam. The report also recommended additional study of various aspects of the Tongue River Project, most of which were later carefully investigated by DNRC.

In 1977, Harlan prepared design and cost estimates that supplemented those presented in 1976. This summary report added four new alternatives and further updated stage one of the high Tongue dam. The four new alternatives were similar to those in Harlan's 1976 report with the addition of spillway crest gates for staged rising of the reservoir. The 1977 report also contained cost estimates for all alternatives.

In 1978, after the May flood damaged the spillway, Northern Testing Laboratories, Inc., acting as a DNRC consultant, prepared a report evaluating the causes for deterioration of the spillway and presenting two alternatives for repair of the damages caused by the 1978 flood. Northern Testing Laboratories reported that the major causes of deterioration were freezing of seepage water under the concrete slabs and uplift pressure on the slabs caused by the rapid flow of water down the face of the spillway.

In 1979, DNRC presented a report to the Forty-Sixth Legislature. The report concluded that legislative action was urgently needed to maintain safe water storage on the Tongue River. Specifically, the report concluded that:

1. Since the existing Tongue River Dam would fail during a flood not much larger than the May 1978 flood and cause extensive property damage and possible loss of life, the State of Montana must build a new dam at the existing site, construct the high Tongue dam, or breach the dam.
2. Because of inadequate information on the alternatives, DNRC should conduct a two-year study to investigate the alternatives and identify a preferred course of action.

In 1980, the US Army Corps of Engineers published a report on the Tongue River Dam as a part of the National Dam Safety Program. The Corps based its findings on a visual inspection made by R.C. Harlan and Associates and on Harlan's data. The Corps concluded that the spillway was incapable of passing the required design flood flow and recommended:

1. An engineering study to determine the exact value of the required design flow for the reservoir.
2. Increased spillway capacity to pass the flood flow without overtopping the embankment.
3. Further study to determine if structural modifications could adequately restore the existing spillway.
4. Development of an emergency warning and operating plan.

E. THE SAFETY PROBLEM

The Phase I inspection report for the Tongue River Project required by the US Army Corps of Engineers as part of the National Dam Safety Program (1980) classified the Tongue River Project as high-hazard. This classification has nothing to do with the present conditions of the structure but instead refers to the potential for loss of life and the magnitude of property damage that would result from failure of the project. The recommended design criterion for high-hazard projects is the ability to accomodate the PMF without failure.

Although the PMF at the Tongue River Project is calculated at 400,000 cfs, the spillway at the project, as mentioned below, is designed theoretically to pass only 98,000 cfs and, in reality, cannot even accomodate much smaller floods. This is the most significant problem with the project. The 7,000-cfs flow that passed over the spillway in the May, 1978 flood severely damaged the structure. Hydrologic calculations indicate that during a routed flood of 20,000 cfs, water would be flowing outside the spillway. This would erode the spillway foundation and adjacent material, causing the project to fail.

Flood routing studies of the reservoir were performed using the standard EM-110-2-1411 method of the US Army Corps of Engineers (1978). These studies determined the inflow necessary to produce a routed flow of 20,000 cfs given a full (68,439 acre-feet), half-full (44,000 acre-feet) and empty reservoir. In order to produce a 20,000 cfs routed flood from a full Tongue River Reservoir, the inflow peak would have to be about 25,200 cfs. An inflow peak of 33,100 cfs for a half-full Tongue River Reservoir and a 51,800-cfs peak inflow for an empty Tongue River Reservoir both would produce 20,000-cfs routed floods.

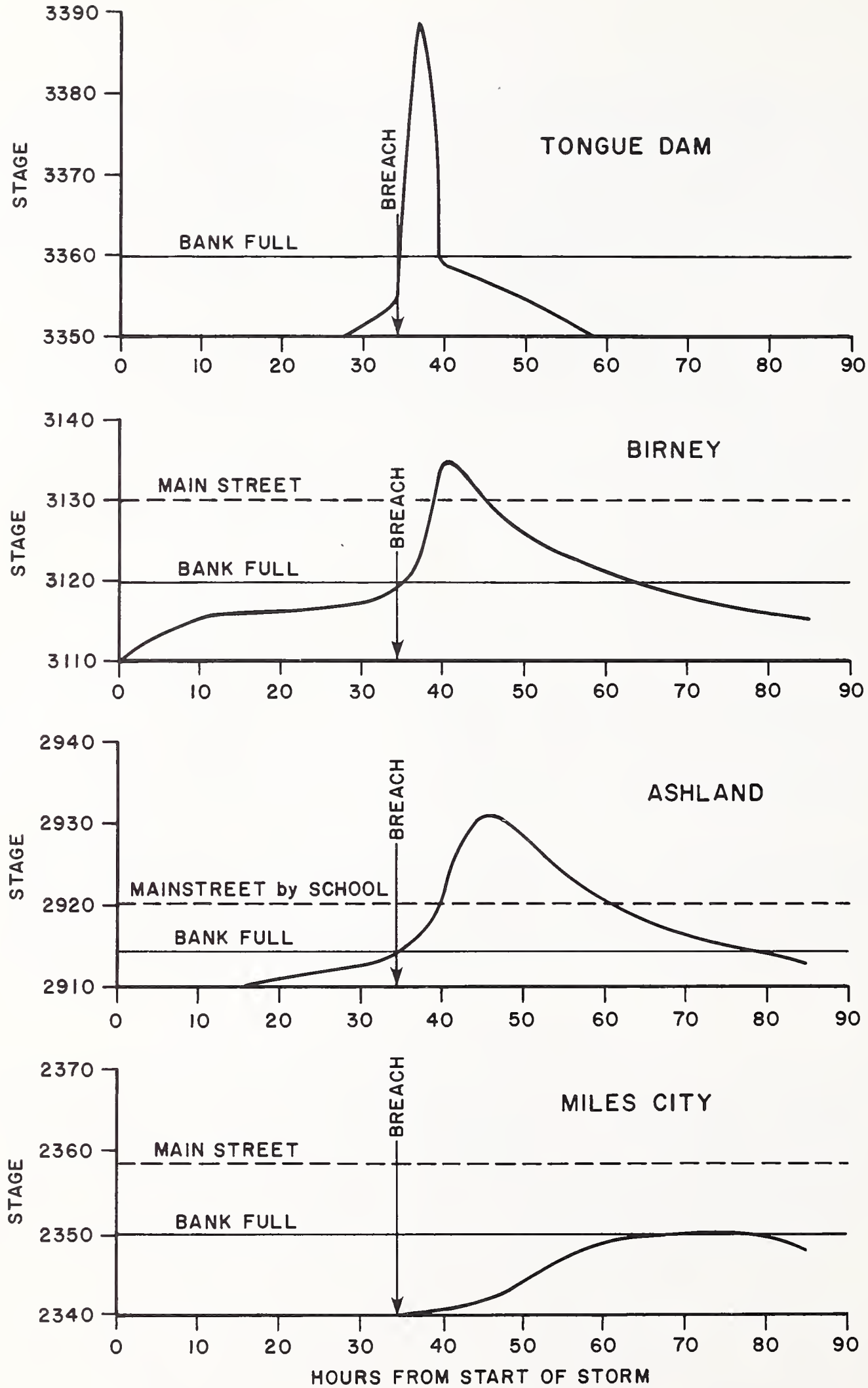
Such inflows appear to be possible at the Tongue River Project. The probabilities of these inflows were calculated from flow records recorded at the Montana-Wyoming border and the probabilities of failure during four time spans are shown in table 3.

Table 3. Probabilities of the Tongue River Project failing assuming that a 20,000-cfs routed flood would cause the project to fail.

Reservoir operation	full	half-full	empty
Amount of water in reservoir	68,439 acre-feet	44,000 acre-feet	0 acre-feet
Inflow necessary for failure	25,200 cfs	33,100 cfs	51,800 cfs
Probability of failure in 10 years	.138	.082	.033
Probability of failure in 12 years	.163	.098	.040
Probability of failure in 14 years	.187	.113	.046
Probability of failure in 16 years	.211	.128	.053

These figures indicate that the chances of the project failing under full operation in any 10-year period (13.8 percent) are fairly high. It should be mentioned that to avoid having to use the spillway, the reservoir has been operated at a level somewhat less than full. However, as table 3 indicates, even at half full, there is better than an 8 percent chance of failure in 10 years.

To estimate the consequences of failure of the Tongue River Project, hydrographs of a flood resulting from failure were prepared for four locations downstream from the project. These were just below the project, Birney, Ashland and Miles City. For this analysis, it was assumed that the reservoir was half full (44,000 acre-feet), the inflow was just sufficient to cause failure (33,100 cfs) and that the reservoir emptied in six hours. These hydrographs are shown in figure 2. The hydrographs show that the river would rise 28 feet above its banks just below the project, 15 feet above its banks at Birney and 18 feet above its banks at Ashland. The flood would attenuate and the peak at Miles City would be about bank-full flow. The hydrographs also indicate that the highest potential for loss of life would be in the area immediately below the project. Residents of that area would have little time to evacuate. People in the areas further downstream would have more time to move to higher ground.



Reservoir initial storage=44,000 acre-feet 33,100 cfs inflow peak.

FIGURE 2

FLOOD ROUTING OF PROJECT FAILURE

(existing dam; storm sufficient to cause breach at 20,000 cubic-feet per second)

3. ALTERNATIVE SOLUTIONS

A. BUILD VERSUS BREACH

Options for the Tongue River Project fall into two major categories--removing the project or constructing a new and better project under one of several construction alternatives (table 4). Breaching would be the least expensive and the most rapid option for eliminating the unsafe conditions posed by the existing structures. However, breaching the existing project eliminates all project benefits such as irrigation water supply, and recreational opportunities, not to mention the numerous adverse environmental impacts. On the other hand, building a new project or rebuilding the existing project not only retains current benefits but, in most cases, increases benefits.

1. Breaching the Dam

While breaching the project eliminates the unsafe condition, it does not satisfy any other of DNRC's goals for the Tongue River Project. However, it may be the only alternative that could generate enough revenue to recover project costs.

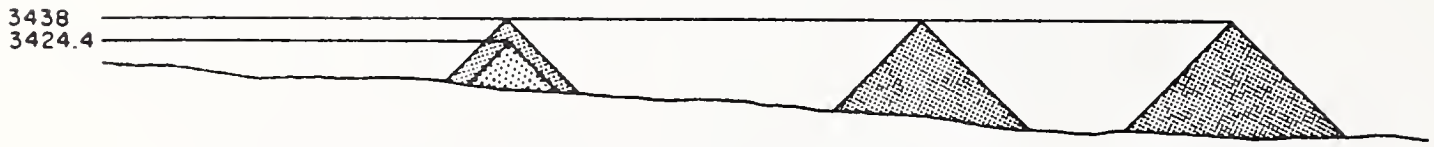
Since the removal of the Tongue River Project would undoubtedly constitute a major state action affecting the human environment, it would require an environmental impact statement (EIS). In addition, the breach alternative would require a federal 404 permit issued by the US Army Corps of Engineers, approval by the Montana Department of Fish, Wildlife and Parks under the Montana Stream Preservation Act [Sections 87-5-501 through 509, MCA (1979)] and a Short-term Activity Authorization [Sections 16-20-633(3), MCA (1979)] from the Water Quality Bureau of the Montana Department of Health and Environmental Sciences. The issuance of the federal 404 permit would most likely require a federal EIS.

Thus, the breach alternative would necessitate at least three permits and possibly two EIS's. However, emergency provisions exist for circumventing or minimizing the lengthy EIS process. DNRC would most likely consider this an emergency situation since the project has a greater than a 10 percent chance of failure in the next 10 years.

In any event, the EIS/permit process would take about three to four years. During this same period, engineering and reclamation studies could begin.

The engineering studies would focus on the method of removing the earth-fill embankment. The reclamation studies and plan would concentrate on revegetating the current reservoir bottom to reduce erosion. These two studies would take about five years, one year beyond the EIS/permit process.

Table 4. Tongue Dam alternatives.



	Repair Existing Dam		Enlarge Existing Dam		Post Creek Dam	High Tongue Dam		Breach Dam
	No Mining	Mine existing reservoir	No Mining	Mine existing reservoir	Mine existing reservoir	Mine existing reservoir	Mine downstream and existing reservoir	
OPTION DESCRIPTION: Water Storage Elev. (Feet above mean sea level)	3424.4	3424.4	3438	3438	3438	3438	3438	N/A
Surface Area(acres)	3300	3300	5000	5000	6500	7700	7700	N/A
Storage Capacity (ac-ft) during mining	N/A	17,000	N/A	17,000	62,000	126,000	68,000 to 126,000	N/A
full development	68,000	68,000	130,000	130,000	223,000	320,000	320,000	0
Firm Annual Yield (ac-ft) during mining	N/A	14,500	N/A	14,500	46,000	81,000	40,000 to 81,000	N/A
full development	52,000	52,000	82,000	82,000	106,000	118,000	118,000	0
Tons Recoverable Coal	N/A	47,700,000	N/A	47,700,000	47,700,000	47,700,000	128,900,000	None
Total Estimated Cost (1980 Dollars)	$67,270,000	$106,499,000	$77,789,000	$108,024,000	$160,263,000	$182,295,000	$211,128,000	$9,716,000
Annual Cost of Water per acre-foot*	$118	$138	$87	$89	$114	$119	$142	N/A

* Annual cost is the initial cost of water amortized over 50 years at 9% interest. Does not include OM & R. Annual cost of water in coal mining options has been offset by present value of coal revenue.

To facilitate the removal of the embankment, the reservoir would be drawn down for one to two years, during which the stream channel and bank vegetation would become re-established. The embankment would then be removed in an orderly fashion, which should take an additional two years.

As table 4 indicates, breaching the project should cost about $10 million (1980 dollars). This does not include financing costs or the possible cost of resolving litigation brought against the state regarding the current water contracts.

Breaching the project would recover 3,500 acres now inundated by the reservoir and another 2,300 acres deeded to the State of Montana (land that would be inundated if a major flood raised the reservoir up to the top of the embankment). DNRC could begin selling the land the year after the project is breached (1984); land sales could last four years. Current land prices in the area of the Tongue River Project average $1,500 per acre--prices that reflect the presence of mineable coal deposits. Based on current land value in the area, it is estimated that land sales could bring about $9 million to DNRC.

Breaching the project would have major adverse environmental, economic, and social impacts. All current project benefits would be lost, including irrigation and stock-water supply, recreational uses, enhancement of fish and wildlife habitat, and moderate flood control.

Farmers and ranchers along the Tongue River below the project rely both on the dependable supply of water the reservoir provides and on the moderate flood protection. In recent years with the increase in coal mining activities, use of the reservoir for recreation such as fishing, boating, water skiing, picnicking,

and swimming has greatly increased. Stabilizing flows during late summer, fall and winter have enhanced the fishing and associated aquatic habitat downstream from the project. These stabilized flows along with the adequate irrigation water have also allowed for the development of increased vegetation in the stream bottom which, in turn, means a more abundant and diverse wildlife resource.

In summary, the Tongue River Project has become a vital part of southeastern Montana. Its removal would have negative short-term and long-term impacts.

2. Building a Dam

A reservoir project alters the natural distribution of water in a watershed and creates a more reliable water supply for agriculture, industry, and recreation. Most reservoir projects also provide some flood control.

Before construction can begin, however, the project must be carefully studied, designed, and scheduled. Then, developers must secure various permits and an EIS must be prepared.

The spillway also requires careful design and planning and must set on a solid foundation to prevent seepage and possible failure. Projects with gated spillways require even more careful design and engineering.

Several preliminary studies are required, usually starting with investigation of hydrological and geotechnical aspects. The hydrological study determines the amount of water available for storage in the watershed and the size to which the spillway must be constructed. The geotechnical study recommends the most suitable dam sites and indicates the extent of supplemental material that will be needed.

If researchers find that the watershed has water for storage and acceptable dam sites, an economic feasibility study begins. This study compares the benefits and costs of the proposed project, using a fairly comprehensive procedure such as that set forth by the federal government. The economic feasibility study includes extensive engineering design and socio-economic research, and results in a list of costs and benefits and a benefit/cost ratio.

Only the high Tongue dam alternative at 3,438 ft MSL has been sufficiently studied to allow developers to confidently plan for design. Specific items requiring study during the feasibility phase of the project follow.

1. Flood studies are refined to select the proper spillway design flood. These studies involve hydrometeorology and reservoir flood routing.
2. The geology of reservoirs and dam sites must be thoroughly studied, particularly for the preferred alternative. Extensive subsurface explorations are required to locate the suitable spillway sites. The geology also affects the amount of seepage control necessary for the reservoir. Seepage, which could undermine the embankment or its immediate abutments, the spillway, or outlet work structure, must be mitigated.
3. Comparative cost estimates are made to find the most economical alternative consistent with project objectives.
4. The design of the spillway, including the stilling basin, must be carefully considered to control downstream erosion during floods. Model studies of proposed spillway configurations should be conducted during the feasibility stage to closely define the proper configuration and cost.

5. If the preferred alternative involves enlargement of the existing project, data must be gathered on the structural integrity of the embankment and its foundation. This includes substantial testing of existing embankment and foundation materials (e.g. soils, coal beds, scoria).

6. Sources of concrete aggregate for grouting and spillway construction must be explored and tested for their suitability. The procurement of an adequate source of concrete aggregate can significantly affect construction cost.

7. Control of seepage downstream of the embankment, particularly with regard to pressure relief within the foundation, must be explored using water pressure tests in drill holes (piezometers). Subsurface seepage data is used in part to design seepage control measures.

8. Although there is relatively little seismic activity in the Tongue River area, the seismic safety of the embankment must be considered.

Developers must secure various permits and compliances before construction begins. For the Tongue River Project, as many as three permits and eight compliances apply to one or more (but not all) of the alternatives. However, all alternatives, except breaching, require at least three similar state permits and compliances.

As mandated by the Montana Water Quality Act, the Water Quality Bureau of the Montana Department of Health and Environmental Sciences administers two of the permits: (1) a Montana Pollutants Discharge Elimination System (MPDES) permit for long-term discharges, (such as effluent from settling ponds used to control turbidity during construction) and (2) a Short-Term Activity Authorization Permit--1620.633 (3). All alternatives call for reservoir pool reduction and construction activities at the dam site which would raise turbidity levels--thus requiring a Short-Term Activity Authorization Permit.

Under the authority of the Montana Stream Preservation Act, the Department of Fish, Wildlife and Parks must approve all construction projects proposed by state or local agencies that alter natural streams. Reduction of the reservoir pool would alter stream configuration in the upper reaches of the existing reservoir and construction activities could affect downstream areas.

All alternatives require a US Army Corps of Engineers 404 permit, thus making the Corps the responsible federal agency. To comply with the US Endangered Species Act, the Corps is required to consult with the US Fish and Wildlife Service to investigate any potential effects of the project on threatened or endangered species. The US Bureau of Land Management may also become involved if any federally owned lands or mineral rights are affected by the project.

All alternatives would require compliance with two executive orders. Executive Order 11988 requires compliance with floodplain-use guidelines and Executive Order 11990 requires examination of alternative actions which would modify or destroy wetlands. The Corps or Bureau of Land Management would be bound to these orders. Rehabilitation of any existing project would probably require compliance since the existing reservoir would have established adjacent wetlands. However, both compliances should be routine.

Constructing a project also requires, under any alternative, the preparation of at least one major EIS, addressing the effect on both the physical and the socio-economic environment. Information compiled during hydrological, geotechnical, and economic-feasibility studies can generally be used in the EIS or EIS's, making the task less extensive. (See The Appendixes to the Tongue River Rehabilitation Project under a separate cover for a more detailed discussion of permits and compliance.)

After all permits are secured and the EIS or EIS's prepared, the project developers must acquire the land that would be inundated by the reservoir. At times, this involves lengthy negotiations with landowners, and in the event of an unwilling seller, land condemnation proceedings.

Assuming the cost/benefit ratio warrants construction, the EIS or EIS's are completed, the necessary permits are obtained, and the land is acquired, final engineering design and construction scheduling can proceed. (The engineering design concentrates on such vital consideration as construction materials, embankment stability, and the hydraulic and structural design of the spillway and outlet works.)

During construction, details concerning foundations of the major structures would probably differ from the original construction design, particularly the embankment foundation. Therefore, geologists must constantly review the exposed foundations during construction and engineers must make necessary changes in engineered construction to provide long-term safety. Lack of continuous review of field conditions and failure to compare these conditions with the design considerations for seepage control and stability of the project were among the major causes leading to the failure of the Teton Dam. Field engineering forces must monitor the construction, making frequent tests to assure that contractors meet all specifications and maintain a complete record of dam construction.

Severe winter conditions often stop construction at Montana dam sites from November through March. Concrete must not be allowed to freeze before it cures and embankments cannot be built with frozen earth material or neither will obtain their design strength. In the spring, frozen materials must be removed from partially completed embankments. Freezing of exposed embankment materials to depths down to 10 feet has been recorded elsewhere in similar climates.

For the alternatives being considered on the Tongue, actual construction would take three to six years, depending on the alternative selected. During the first year, efforts would concentrate on construction of the outlet works and coffer dams so the river could eventually be moved from its channel through the outlet works. The part of the dam foundation not lying in the river channel would also be prepared during the first year of construction. Also during the first year, some embankment construction and spillway excavation would take place, facilities for mixing and handling concrete would be installed, borrow areas would be developed, haul roads would be built, and contractors' offices, equipment maintenance facilities, engineering offices and laboratories would be set up.

In the second year, preparation of the embankment foundation and construction would continue, spillway excavation, foundation preparation, and structural concrete work would proceed, and the outlet works would be completed except for valve installation.

If the project is an enlargement of the existing project, the spillway and embankment work would be completed and the hydroelectric plant would be installed during the third year. At a new dam site, the third year would bring the spillway near completion and the embankment would be complete except in the river channel. In the latter part of the third year, a coffer dam would be closed, diverting the river into the outlet works. The embankment foundation in the river channel would then be excavated and the embankment constructed back to the river level.

In the fourth year, the embankment and spillway would be completed, the outlet works valves installed, and the hydroelectric plant finished. The fourth year also means the construction of miscellaneous bridges and roads, instrumentation, and other finishing touches.

For some of the alternatives on the Tongue with mining options, a split construction period would be envisioned. This would have the effect of causing a one- to two-year increase in the overall construction period.

Following construction of the project (which would include installing instrumentation for monitoring seepage in the embankment and adjacent to the embankment and spillway foundations), the reservoir could be filled. For the alternatives being considered, estimates for filling the reservoir would range from two to four years, based on average flows on the Tongue River. As the reservoir fills, careful monitoring would be required of the instrumentation installed to determine the seepage pressure developing downstream from the reservoir and under the dam and spillway. If pressures develop higher than those allowed in the embankment (due to unanticipated stratification of the foundation), then remedial measures such as relief wells and horizontal drains must be installed. After the reservoir would be filled and placed in full operation, a period of extensive maintenance would initially be required to correct any unsatisfactory drainage conditions which would develop as a result of severe winters or unanticipated foundation conditions. The construction and filling of the reservoir could vary from five to 10 years depending on the alternative.

Figures 3 and 4 show the plan and profile of a typical earth-fill project. The essential features to such a dam include the embankment, the outlet works and the spillway. The embankment blocks the original flow of the river and so raises the reservoir. The outlet works handle the normal releases from the reservoir. The spillway acts as a safety valve. When the reservoir receives an inflow so large that the outlet works and allotted storage space cannot handle it and water would otherwise overtop the embankment and wash it out, the spillway safely routes the flood around the dam and passes it downstream.

The alternatives that include coal mining would require gated spillways in order to adjust the water level in the reservoir to accomodate mining operations. Gated spillways, however, are much more expensive than ungated spillways for two reasons. First, gates obviously require the expenses of design, manufacturing and installation. Operation and maintenance of gates are also expensive. The second reason is less obvious. Spills normally flow out beneath spillway gates. When a spill overtops the gates, the gates are severely damaged or destroyed. To prevent this, in a flood situation, the gates are raised to match outflow with inflow, cfs for cfs. Consequently, a gated spillway must be large enough to carry the entire PMF. Larger spillways are, of course, more expensive.

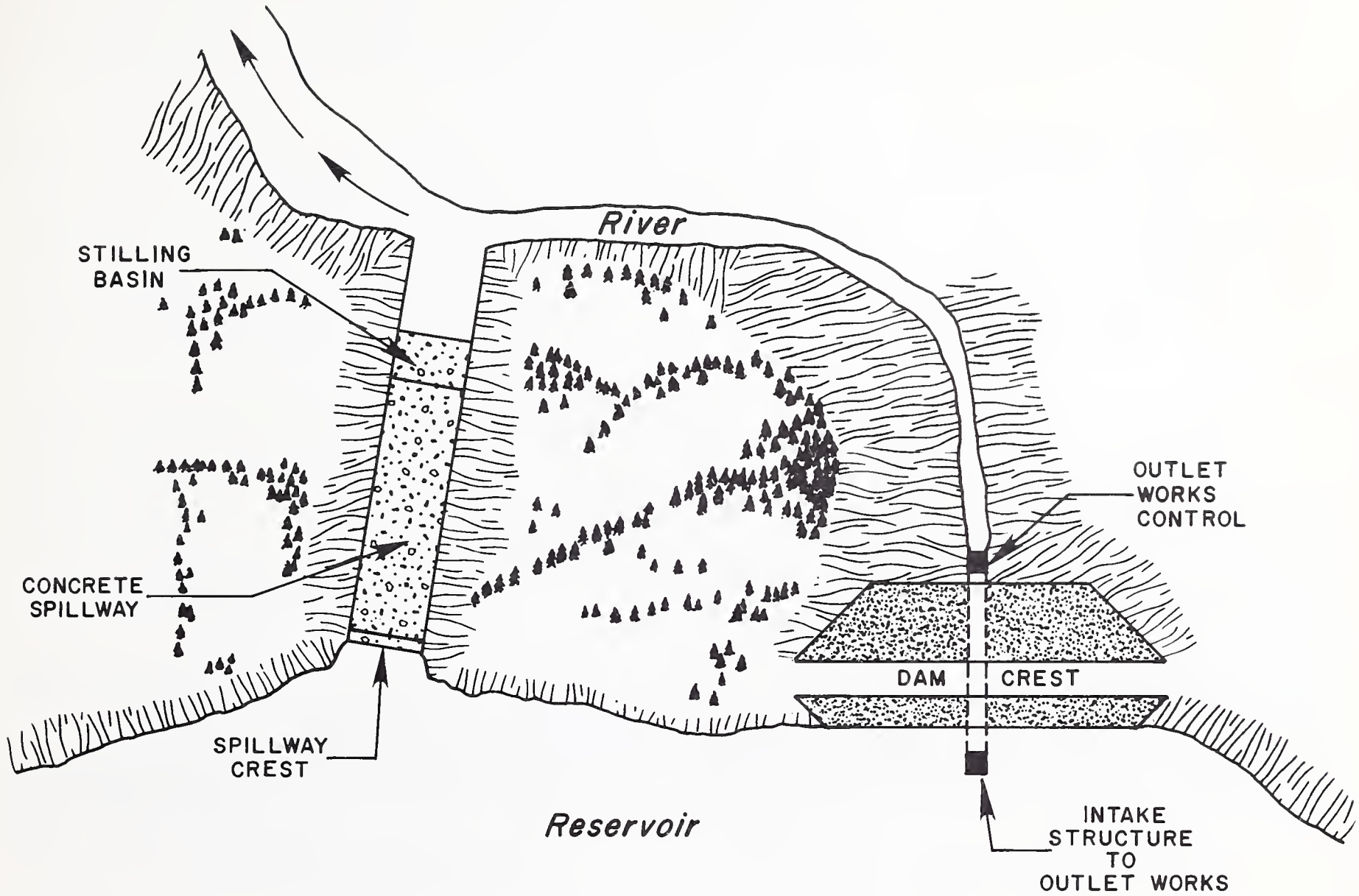
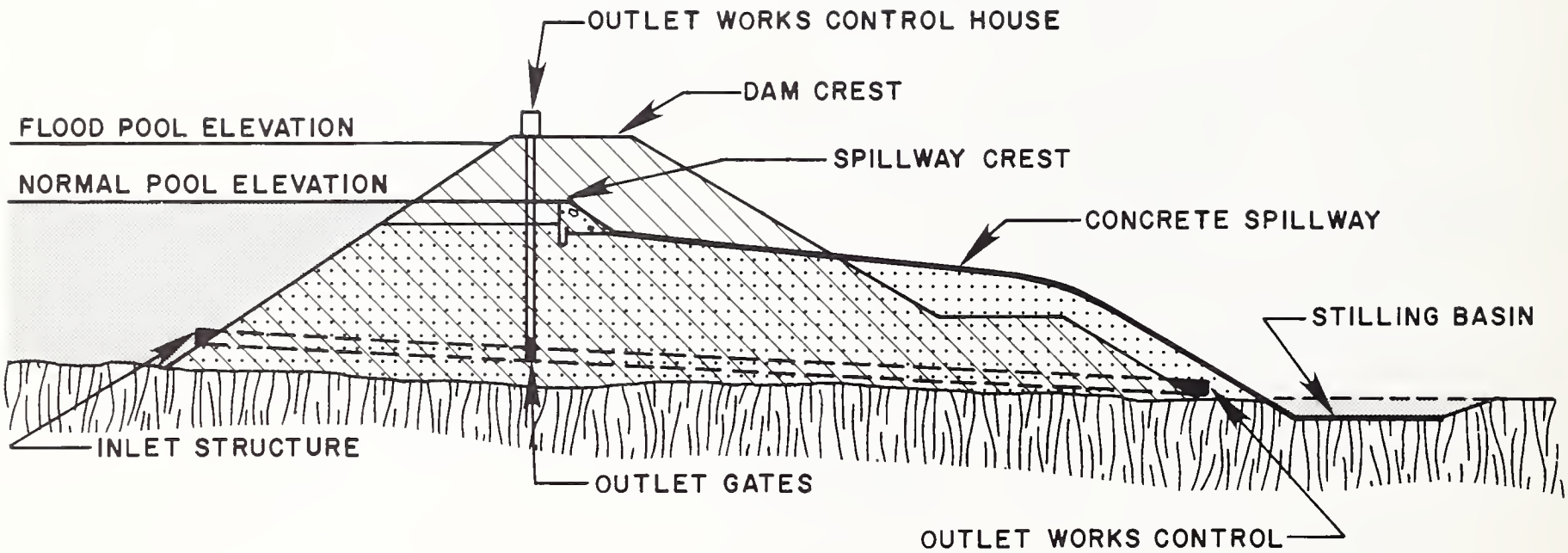


FIGURE 3

TYPICAL EMBANKMENT AND SPILLWAY PLAN



Note: Vertical scale exaggerated

FIGURE 4

SUPERIMPOSED PROFILES OF TYPICAL SPILLWAY AND EMBANKMENT

Ungated spillways obviously do not require the expenses associated with gates. Moreover, ungated spillways can be smaller, and so less expensive, by taking advantage of what is called surcharge. Surcharge is the volume of the reservoir associated with the freeboard which is the vertical distance between the crest of the spillway and the crest of the embankment.

The strategy used to design the least expensive earth-fill dam recognizes that the costliest item is the spillway and that an ungated spillway does not have to carry the entire PMF if part of the inflow can be temporarily stored in the reservoir's surcharge. By raising the embankment to increase the freeboard, and consequently the surcharge, the capacity of the spillway, and so its expense, can be decreased. The degree to which this is done depends on when raising the dam becomes more expensive than constructing even a smaller spillway, and ultimately on the topography of the dam site.

This strategy also provides the additional benefit of a certain amount of flood control. The dam protects downstream areas from floods by temporarily storing the inflow in the surcharge and then letting the water out at a slower rate determined by the capactiy of the spillway. Because gated spillways must match outflow to inflow, they sacrifice a large degree of flood control. Of course, operating the reservoir well below the spillway crest would provide flood control in either case but the flood control would come at the expense of the reservoir's yield.

As mentioned before, the dam site's topography ultimately determines how much surcharge can be designed into a project. Because the sites under consideration do no allow for much freeboard, any surcharge storage available at these sites would be negligible compared to the large floods that are possible on the Tongue River. Consequently, any alternative's spillway would have to be large enough to pass, for practical purposes, the entire PMF. This means that the spillway of any alternative will be expensive and that, unless that dam would be operated especially for flood control, little flood control would be provided for large floods.

B. CRITERIA FOR CONSTRUCTION ALTERNATIVES

The criteria used to select alternatives for investigation were, essentially, the ability to satisfy the goals of the project and engineering and financial feasibility.

Some alternatives for investigation were proposed by the general public and special interest groups. One proposal to solve the project's safety problem was presented by a member of the Tongue River Water Users' Association (TRWUA), Hugo Muggli, who uses Tongue River Project water for irrigation. Although it is apparent that a considerable amount of thought was put into this proposal, it fails to adequately alleviate the safety problem, which is the principal criterion any acceptable alternative must meet. Mr. Muggli's proposal involves a new earthen auxiliary spillway to provide additional capacity and the use of coal mining pits at the East Decker mine for increased storage.

At one time, the Decker Coal Company proposed to reclaim the pits by filling them with water and changing their use to recreation, rather than refilling the pits with earth and restoring the land to its original use. According to the Department of State Lands, however, this would not have been a satisfactory reclamation procedure. It is doubtful that the Department of State Lands would approve such a reclamation procedure even if it were connected with the Tongue River Project.

Regardless of whether the plan would be approved or not, it is doubtful that using the pits would add significant active storage to the project. Since the greater part of both pits would be lower than the floor of the reservoir, most of the water would have to be pumped out of the pits before it would provide useful storage. Muggli proposes to use energy provided by the hydroelectric plant planned for the project to run the pumps. Still, it may not be possible to convert the water in the pits to active storage. The coal seam that the mining operation was following can serve as an aquifer and slopes up from the bottom of the pit to outcrop in the reservoir. Because of that, any water pumped out of the pits would be replaced by water flowing back from the reservoir through the coal seam. This problem could only be solved by extensive sealing of the connecting coal seams. However, the cost of water from these pits may be competitive with water supplied from an enlarged reservoir and will be further analyzed.

Additionally, Muggli proposed to leave the present spillway and embankment in their present conditions and to add a new earthen spillway on the west abutment. The earthen spillway's crest elevation would be 12 feet below that of the present spillway crest. An 18 foot-high earthen dike would be constructed across the new spillway. When the present spillway's safe capacity (which is no more than 20,000 cfs) is exceeded, the earthen spillway would be engaged by instantaneously removing part of the dike through the detenation of a previously placed explosive charge. This is intended to prevent damage of the present spillway and overtopping of the embankment by routing the water through the earthen spillway.

Muggli did not appear to propose geotechnical investigations of the new spillway's site or any technical design and proposed that materials taken from the cut be used as riprap on the spillway. Prices quoted by the Muggli proposal reflect economical excavation in extremely soft material which indicates that the site would not be suitable for an earthen spillway. DNRC does expect, however, that an earthen spillway site on formations more durable (and more difficult to excavate) can be found.

As the Muggli proposal now stands, however, once part of the dike would be removed, the entire dike would erode in minutes, adding about 60,000 cfs to the 20,000 cfs passing through the present spillway. If the earthen spillway is located on soft material, it is possible that the spillway may erode so much that the project would no longer be able to store any water. Even assuming that the spillway would not erode, the combined capacity of the two spillways would be no more than 80,000 cfs. The PMF, which is the design flood for a safe, high-hazard project, at the location of the Tongue River Project, is estimated at 400,000 cfs.

After a review of the Muggli proposal, DNRC has determined that the proposal would not correct the unsafe condition of the project, and, in view of some aspects of the proposal, make the project more unsafe than it is now.

Additionally, it would not be effective in increasing the benefits or yield of the Tongue River Project. Furthermore, the Muggli proposal would be considerably more expensive than originally suggested. It should also be noted that a motion to adopt the Muggli proposal was defeated at a meeting of the TRWUA on December 30, 1980.

Besides the Muggli proposal, there were other, more obvious alternatives for further study. In the area between the present dam site and the high Tongue dam site about 7.5 miles downstream, the Tongue River has cut through a geological uplift creating a small canyon which is an obvious place to look for a dam site. Because the largest reservoir would be raised by placing a dam at the high Tongue site at the lower end of the canyon, previous studies concentrated on that dam site as an alternative to the present dam. Substantial geotechnical information concerning the present site was also available from the studies made in preparation for building the present dam. Since so much information was on hand for these two sites, DNRC concentrated on them as obvious choices for further investigation.

A maximum normal surface elevation of 3,438 ft MSL was chosen for three reasons. First, at that elevation, the reservoir would not back up into Wyoming. A reservoir crossing the Montana-Wyoming border would not be illegal, since the Yellowstone River Compact provides a mechanism for such a project, but it would add to the complexity of the project. The second consideration concerns coal mines near the Tongue River Reservoir. At 3,438 ft MSL, the reservoir would not inundate any mines. Third, since the high Tongue dam alternatives at 3,438 ft MSL would produce more water than forseeable demand, larger reservoirs did not seem to be justified.

Another factor concerning the reservoir surface elevation was the possibility of mining the coal lying beneath the present reservoir and beneath the area between the present Tongue dam and the high Tongue dam site. Some alternatives contemplated this coal as a source of revenue for the project. To accomodate the mining operations, it was determined that some alternatives would need the ability to lower the reservoir surface elevation to 3,400 ft MSL for the duration of the mining period.

Finally, the minimum final reservoir surface elevation considered for any alternative was 3,424.4 ft MSL, the surface elevation of the present project, since smaller reservoirs would not be able to meet present demands.

C. DESCRIPTION OF CONSTRUCTION ALTERNATIVES

1. Existing Site

There are two primary alternatives at the existing site. One slightly increases the water supply; the other approximately doubles the firm annual yield by increasing the storage capacity of the reservoir. Coal mining was considered as an option with each alternative (repair and enlarge) at the existing site. Thus, four options were actually considered at the existing site.

The alternative of repairing the existing project could increase the firm annual yield from 40,000 to 52,000 acre-feet. Although this option would not increase

storage capacity, it would allow operation of the reservoir at maximum level. As mentioned before, the reservoir is operated below capacity to avoid using the unsafe spillway. Operating the reservoir below capacity provides some increased flood control, a benefit which would be reduced with operation at maximum capacity.

Under the repair alternative, the embankment would be raised to provide more freeboard to control a larger flood. The present outlet works would be used, but modified by installing steel conduit with butterfly valves downstream from the existing gate structure. The conduit would lead to a small hydroelectric plant and discharge structure. The two-unit hydroelectric plant would have a capacity of 1.95 megawatts (MW) and would annually produce an estimated 6.9 million kilowatt-hours (kWh).

The other alternative, enlarging the existing project, would increase the capacity of the reservoir to 130,000 acre-feet providing a firm annual yield of 82,000 acre-feet. The existing outlet works would be used. However, the current spillway would be filled in and made part of the embankment. The new, normal water storage elevation would be 3,438 ft MSL, creating a 5,000-acre reservoir. This alternative also includes a 2.6 MW hydroelectric plant with an estimated annual production of 10.2 million kWh.

Without coal mining, the first alternative (repairing the project) would require the modification of the existing spillway to create a structure capable of handling a much larger flow. However, the service spillway would not totally accomodate passage of the PMF. Therefore, this option would require an additional auxiliary spillway capable of passing the balance of the PMF.

With the reservoir full, anything greater than a 25-year flood would engage both the service and auxiliary spillways. For example, a flood similar to the May 1978, flood (19,000-cfs inflow), would cause spillage through the auxiliary spillway.

The no-mining option of the repair alternative could be constructed in two years (see table 5). This would be preceded by two years of environmental studies and permit procurement. Assuming financing were immediately available, construction would begin in 1983, and the reservoir would be fully operational by 1985.

Table 5. Schedule for repair of the Tongue River Project at the existing site--no mining.

YEARS	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05
Coal leasing package	NOT NEEDED																									
Environmental studies & permits		X	X																							
Engineering design & studies		X	X	X																						
Dam & spillway construction				X	X																					
Coal mining	NO MINING																									
Reservoir filling	NOT NEEDED																									

Figure 5 illustrates this option, and table 6 summarizes pertinent physical data.

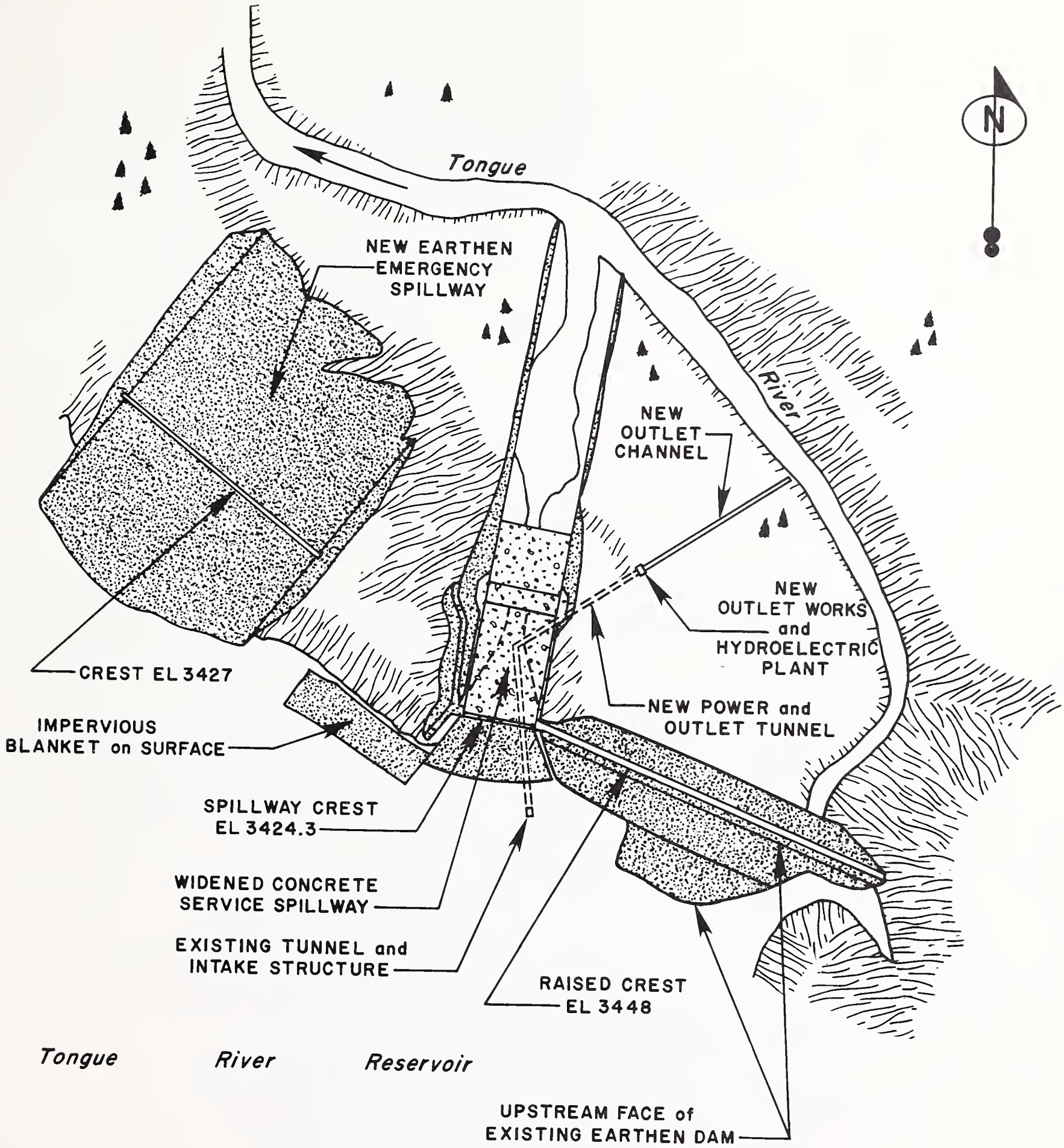


FIGURE 5

REPAIR SPILLWAY AT PRESENT SITE, NO MINING

Table 6. Pertinent physical data on the no-mining option for repair of the Tongue River Project at the present site.

RESERVOIR	
Drainage area	1,770 mi4
Storage at spillway crest	69,439 acre-feet
Storage at embankment crest	150,000 acre-feet (approx.)
Surface area at spillway crest	3,497 acres
SERVICE SPILLWAY	
Type	Ungated concrete rectangular chute
Width	350 feet
Crest elevation	3,424.4 ft MSL
Capacity with water surface at elevation 3,442.4 ft MSL	107,000 cfs (est.)
AUXILIARY SPILLWAY	
Type	Ungated, earthen, rectangular chute
Width	1,000 feet
Crest elevation	3,427 ft MSL
Capacity with water surface at 3,442.4 ft MSL	300,000 cfs (est.)
OUTLET WORKS	
Inlet structure	Box type
Conduit	Horseshoe-shaped, reinforced concrete lined tunnel, 16-foot equivalent diameter
Capacity with gates open and water surface at elevation 3,442.4 ft MSL	4,300 cfs (est.)
Control	Two 6- x 12-foot slide gates
EMBANKMENT	
Type	Zoned earth-fill
Crest elevation	3,445 ft MSL
Freeboard above normal water surface	18.0 feet (3,442.4 ft MSL)
Crest width	54.5 feet
Length	1,824 feet
Maximum height	93.6 feet

With coal mining, the repair alternative would require a new spillway. Since, a reduced water level (3,400 ft MSL) would be needed during mining, the current structure could not be used. Initially, the new spillway would have a crest elevation of 3,400 ft MSL which would be increased to 3,424.4 ft MSL at the conclusion of mining.

Under this option, the present spillway would be filled in, becoming part of the embankment, and the new spillway would be located west of the existing spillway. During the mining (estimated at 11 years), the reservoir's firm annual yield would be reduced to about 14,500 acre-feet.

The mining option of the repair alternative would require a split five-year construction period preceded by two years of environmental studies and permit procurement. All but the hydroelectric facilities would be constructed prior to mining. The schedule for the construction of the hydroelectric facilities coincides with the completion of mining. Although the actual mining should take about 11 years, coal leasing activities and the acquisition of a mining permit may take up to nine years. Thus, the mining activities could last until 2000.

The scheduling of the construction and engineering work would involve the building of the new spillway at an elevation of 3,400 ft MSL and additions and corrections to the embankment and outlet works to assure safety. The spillway chute walls, crest walls, floor slabs, bridge piers, and stilling basin would be built as a part of the first stage.

The first stage should be completed by 1985. Construction and engineering should resume in 1999 with the raising of the spillway crest by the installation of a 24.4-foot-high ogee section and the hydroelectric plant. The second stage would be completed and the reservoir fully functional by 2003 (table 7). In table 7, note the four-year period (1986-1989) between the completion of the first stage of construction (which will lower the reservoir) and the beginning of mining. This assumes that it would take a mining company seven years to get a mining permit from the time the coal is leased.

Table 7. Schedule for repairing the Tongue River Project at the existing site with mining.

YEARS	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05
Coal leasing package			X	X	X																					
Environmental studies & permits	X	X																								
Engineering design & studies	X	X	X	X	X													X	X	X						
Dam & spillway construction			X	X	X														X	X						
Coal mining										X	X	X	X	X	X	X	X	X	X	X						
Reservoir filling																						X	X			

Figure 6 illustrates this option, and table 8 summarizes pertinent physical data.

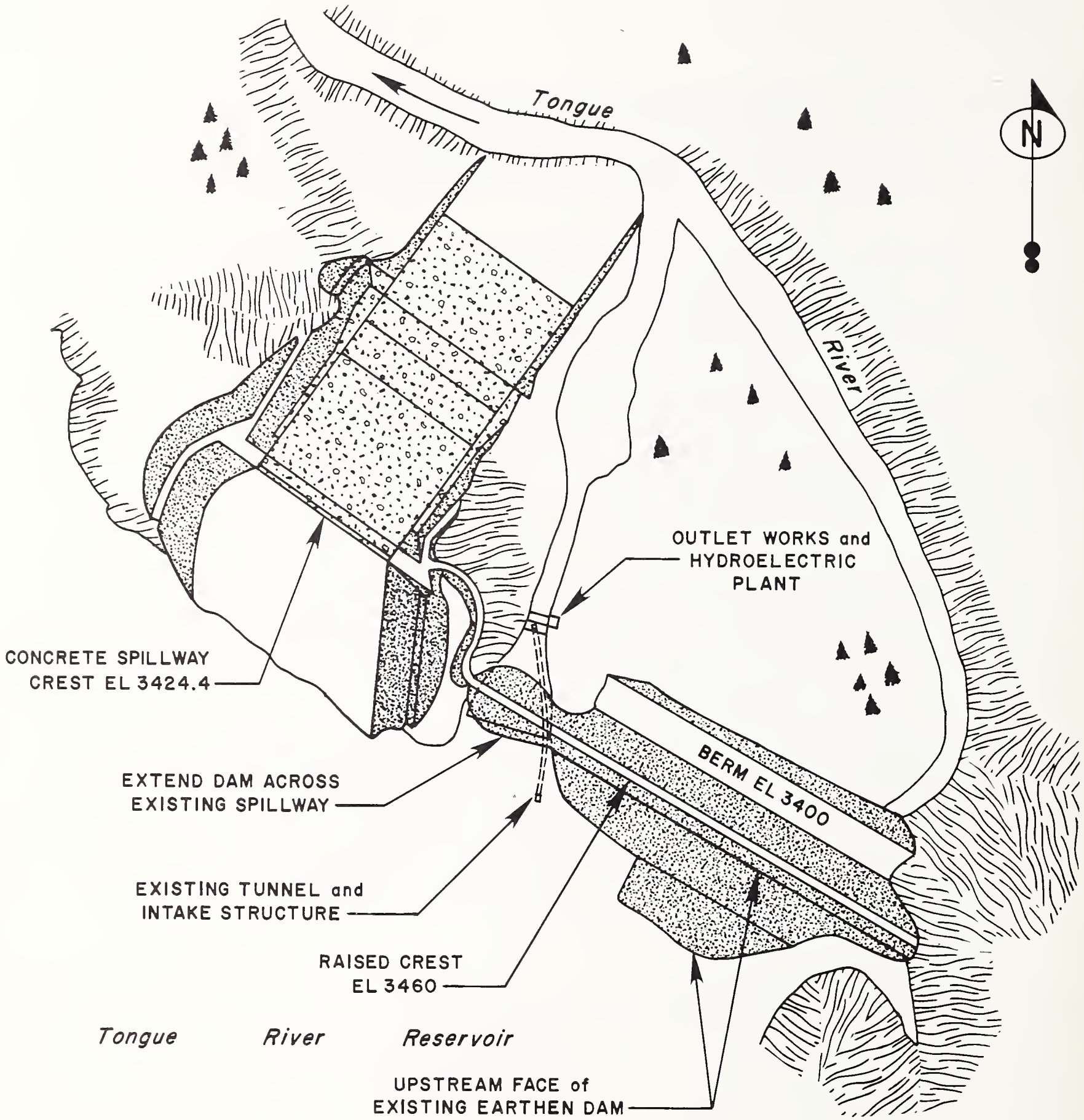


FIGURE 6

REPLACE SPILLWAY AT PRESENT SITE, MINE COAL

Table 8. Pertinent physical data on the mining option for repair of the Tongue River Project at the present site.

RESERVOIR	
Drainage area	1770 mi^2
Storage at spillway crest	69,439 acre-feet
Storage of top of embankment	150,000 acre-feet (est.)
Surface area at spillway crest	3,497 acres
SPILLWAY	
Type	Ungated, ogee, concrete rectangular chute
Width	685 feet
Crest elevation	3,400 ft MSL (initial) to 3,424.4 ft MSL (final)
Capacity with water surface at elevation 3,442.4 ft MSL	400,000 cfs (est.)
OUTLET WORKS	
Inlet structure	Box type
Conduit	Horseshoe shaped, reinforced concrete-lined tunnel, with 16-foot equivalent diameter
Capacity with gates open and water surface at elevation 3,442.4 ft MSL	4,300 cfs
Control	Two 6 x 12 foot slide gates
EMBANKMENT	
Type	Zoned earth-filled
Crest elevation	3,455 ft MSL
Freeboard above normal water surface (final spillway crest)	18.0 feet (3,442.4 ft MSL)
Crest width	54.5 feet
Length	2,174 feet
Maximum height	103.6 feet

The no-mining option for enlarging the dam requires a new service spillway about 2,000 feet west of the present spillway. The service spillway would be concrete-lined and sized to pass at least 60,000 cfs. In addition, an earthern auxiliary spillway would be built between the new service spillway and the existing spillway to handle the remainder of the PMF. A dike would be built across the existing spillway with extensive seepage control provisions, essentially making it part of the embankment.

The no-mining option of the enlarge alternative would require three years of construction preceded by four years of environmental studies and permit procurement. Construction could begin in 1985 and finish in 1987. After taking about two years to fill, the reservoir would be fully operational by 1990 (table 9).

Table 9. Schedule for enlarging the Tongue River Project at the existing site--no mining.

YEARS	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05
Coal leasing package	NOT NEEDED																									
Environmental studies & permits		X	X	X	X																					
Engineering design & studies			X	X	X	X	X	X																		
Dam & spillway construction						X	X	X																		
Coal mining	NO MINING																									
Reservoir filling									X	X																

Figure 7 illustrates this option, and table 10 summarizes pertinent physical data.

The mining option of the enlarge alternative would require a new gated spillway. The spillway would be designed with a control sill at 3,400 ft MSL to allow mining in the upper portion of the reservoir. After mining, the spillway gates would be adjusted to allow additional water storage by increasing the elevation. This new spillway would be designed to handle the entire PMF. The existing spillway would be filled in, essentially making it a part of the embankment.

The mining option would require a split five-year construction period, preceded by five years of environmental studies and permit procurement. During this pre-construction period (table 11), the preparation for coal leasing could proceed and engineering design and studies would begin and extend through the construction period. In total, nine years of engineering would be required, a portion of which would be necessitated by the split in the period of construction.

Table 11. Schedule for enlarging the Tongue River Project at the existing site--with mining.

YEARS	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05
Coal Leasing Package	X	X	X	X																						
Environmental studies & permits		X	X	X	X																					
Engineering design & studies				X	X	X	X	X	X										X	X	X					
Dam & spillway construction							X	X	X											X	X					
Coal mining											X	X	X	X	X	X	X	X	X	X	X					
Reservoir filling																				X	X	X				

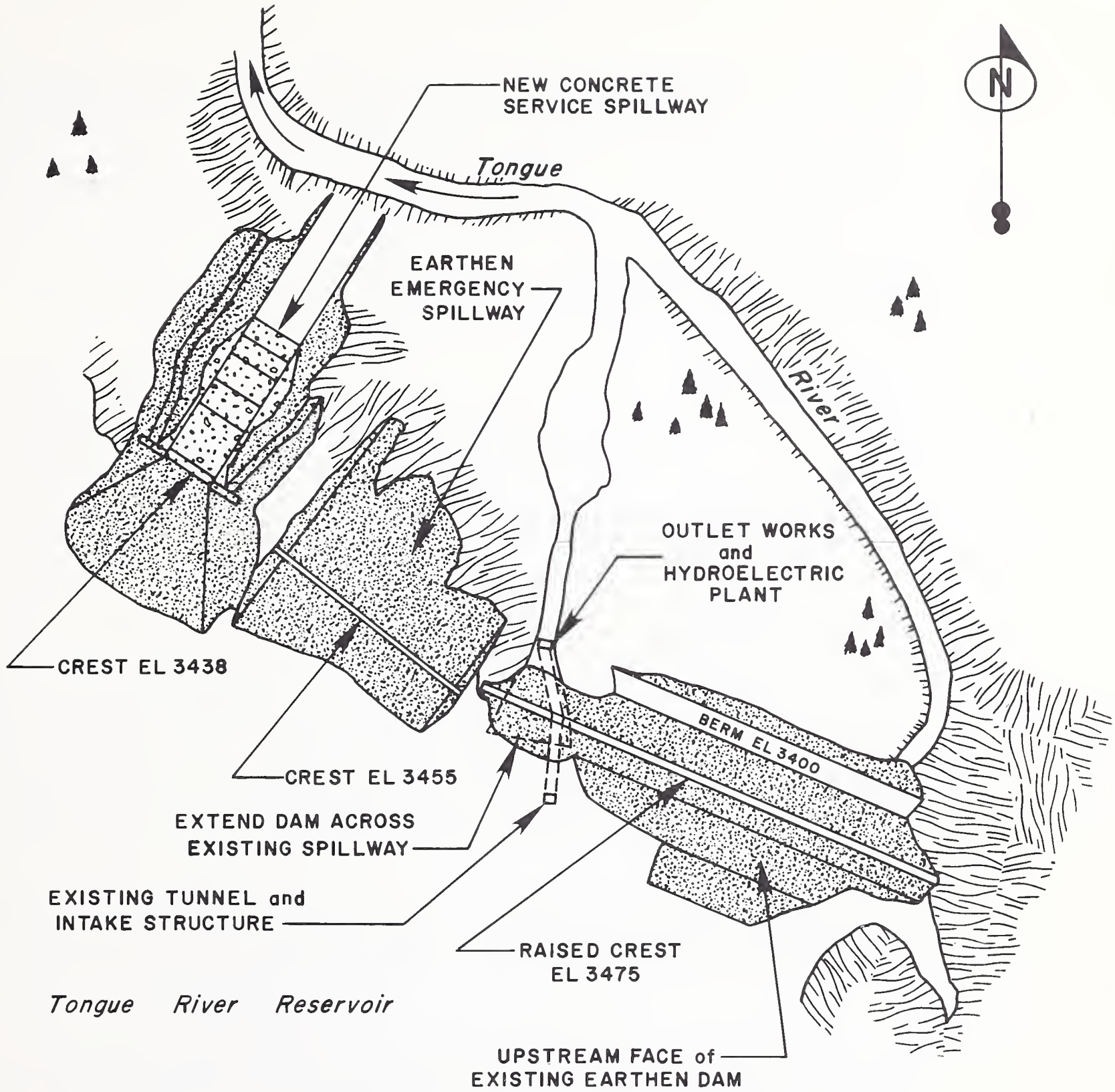


FIGURE 7

ENLARGED DAM AT PRESENT SITE, NO MINING

Table 10. Pertinent physical data on the no-mining option for enlargement of the Tongue River Project at the existing site.

RESERVOIR	
Drainage area	1770 mi^2
Storage at spillway crest	130,000 acre-feet
Storage at top of embankment	380,000 acre-feet (est.)
Surface area at spillway crest	5,000 acres
SERVICE SPILLWAY	
Type	Ungated, concrete-lined, rectangular chute
Width	250 feet
Crest elevation	3,438 ft MSL
Capacity with water storage at 3471.5 ft MSL	194,000 cfs (est.)
AUXILIARY SPILLWAY	
Type	Earthen, rectangular chute with wier
Width	1,200 feet
Crest elevation	3,455 ft MSL
Capacity with water surface at 3471.5 ft MSL	320,000 cfs (est.)
OUTLET WORKS	
Inlet structure	Box type
Conduit	Horseshoe-shaped, reinforced concrete-lined tunnel, 16-foot equivalent diameter
Capacity with gates open and water surface at 3,471.5 ft MSL	4,300 cfs
Control	Two 6 x 12 foot slide gates
EMBANKMENT	
Type	Zone earth-filled
Crest elevation	3,475 ft MSL
Freeboard above normal water surface	33.5 feet
Crest width	54.5 feet
Length	2,325 feet
Maximum height	123.6 feet

A two-stage construction period is planned. The first stage of construction (three years) would result in a safe structure producing a water level low enough for mining. The second stage (two years) would be scheduled to conclude when mining would be completed. This stage involves raising the water level by the installation of spillway gates, and building a hydroelectric plant. After construction and mining concluded in 2000, the reservoir would take about two more years to fill, making it fully operational in 2003.

Figure 8 illustrates this option, and table 12 summarizes pertinent physical data.

2. Post Creek Dam Site

DNRC developed the Post Creek alternative in response to the objectionable period for which the reservoir would be drawn down to accommodate mining in options at the existing site. A Post Creek dam with an initial water level at 3,400 ft MSL would create a reservoir capable of supplying a firm annual yield of 46,000 acre-feet. Thus, mining could be accommodated in the upper part of the reservoir while allowing all current water use to continue. Once mining would be completed, the water level could be raised to 3,438 ft MSL, which would increase the firm annual yield to 106,000 acre-feet.

The Post Creek site lies about four miles downstream from the present site. The spillway, a fully concrete-lined, rectangular chute, would be located on the west abutment and would include a stilling basin for downstream erosion control. The spillway would have a 410-foot-wide control sill at 3,400 ft MSL to allow mining in the upper reservoir. The spillway structure would have seven radial control gates and a bridge for access to the dam. At the end of the mining period, the radial gates would be lowered, allowing the water level to rise to 3,438 ft MSL.

The embankment would be zoned, earth-filled, and approximately 150 feet high. The outlet works, located at the base of the west abutment, would be a combination of concrete and steel conduit in either a tunneled or cut-and-cover fashion.

A 4.7-MW, two-unit hydroelectric power plant would be located at the downstream end of the outlet works, generating approximately 6.8 million kWh annually during the period of mining and about 17.75 million kWh annually when the project becomes fully operational.

The adequacy of the Post Creek site has not been investigated to the degree the other sites have. In fact, only a geological reconnaissance of the area has been made. However, this preliminary reconnaissance did not reveal any features which would preclude the building of a dam.

Construction at the Post Creek site would take four years, beginning as soon as environmental studies and engineering design would be complete and necessary permits obtained (table 13). These pre-construction activities could take up to five years, delaying construction to 1986. During this pre-construction period, coal leasing could occur, allowing mining to begin in 1990. This assumes a reasonable period (seven years) for a mining company to obtain a mining permit and for an EIS to be prepared.

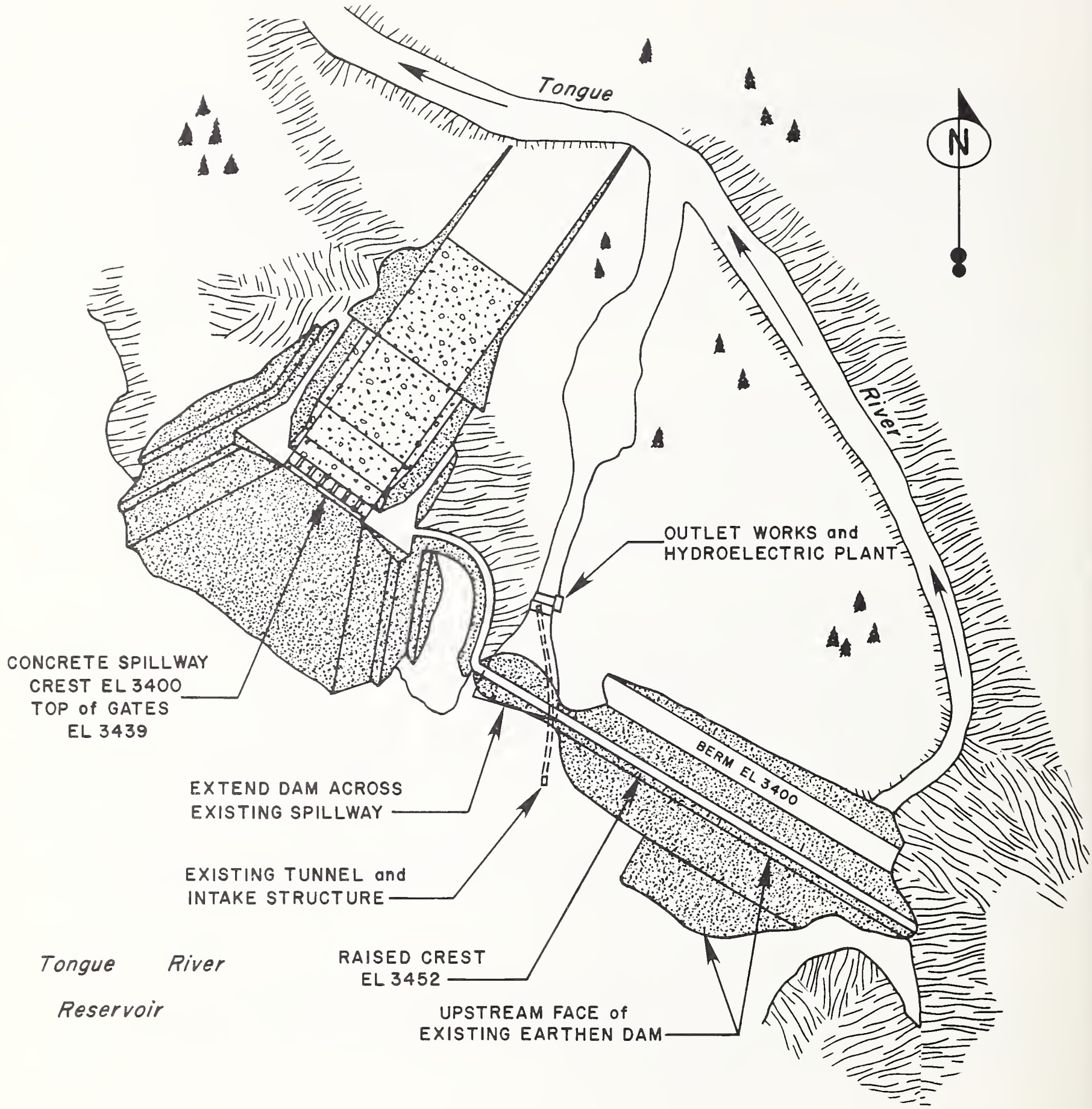


FIGURE 8

ENLARGE DAM AT PRESENT SITE, MINE COAL

Table 12. Pertinent physical data on the mining option for enlargement of the Tongue River Project at the existing site.

RESERVOIR	
Drainage area	1770 mi^2
Storage at spillway crest	130,000 acre-feet
Storage at top of embankment	205,000 acre-feet (est.)
Surface area at spillway crest	5,000 acres
SPILLWAY	
Type	Gated, reinforced concrete-lined, rectangular chute
Width	410 feet
Crest elevation	3,400 to 3,438 ft MSL
Capacity with water surface at 3,446.6 ft MSF	400,000 cfs (est.)
OUTLET WORKS	
Inlet structure	Box type
Conduit	Horseshoe-shaped, reinforced concrete-lined tunnel, 16-foot equivalent diameter
Capacity with gates open and water surface at 3,442.4 ft MSL	4,300 cfs (est.)
Control	Two 6 x 12 feet slide gates
EMBANKMENT	
Type	Zoned earth-filled
Crest elevation	3,452 ft MSL
Freeboard above normal water surface	14 feet
Crest width	54.5 feet
Length	2,225 feet
Maximum height	100.6 feet

Table 13. Schedule for the Post Creek alternative.

YEARS	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05
Coal leasing package		X	X	X	X																					
Environmental studies & permits		X	X	X	X	X																				
Engineering design & studies		X	X	X	X	X	X	X	X	X																
Dam & spillway construction							X	X	X	X																
Coal mining											X	X	X	X	X	X	X	X	X	X	X					
Reservoir filling																						X	X			

The entire project would be built, including installation of the hydroelectric plant and removal of the existing dam, prior to the beginning of mining. Mining would start the year after construction terminates and proceed through 2000. The spillway gates would then be lowered and after two years the reservoir should be at capacity.

Figure 9 illustrates the Post Creek alternative, and table 14 summarizes pertinent physical data.

3. High Tongue Dam Site

The 1969 Bechtel report extensively investigated the high Tongue dam site which lies about 7.5 miles below the existing dam near the confluence of Four Mile Creek. This alternative has two options, both involving coal mining. However, both options would result in the same project with a reservoir capable of supplying a firm annual yield of 118,000 acre-feet.

The earth-fill embankment would be about 180 feet high. The spillway, a fully concrete-lined, rectangular chute with a stilling basin for erosion control, would be on the west abutment. The 40-foot side wall structure, at 3,400 ft MSL, would have seven radial gates to allow raising the reservoir level to 3,438 ft MSL. A bridge over the spillway would allow access to the dam. This spillway would be able to pass the PMF.

The outlet works, located at the base of the west abutment, would be a combination concrete and steel conduit in a cut-and-cover trench, leading to a two-unit hydroelectric plant and discharge structure. The 6.6-MW hydroelectric plant would annually produce an estimated 26.25 million kWh.

The first option at the high Tongue dam site is similar in concept to the Post Creek alternative. This option would have an initial water level at 3,400 ft MSL. Once construction of the new dam would be completed, the existing, unsafe structure would be breached.

At 3,400 ft MSL, the reservoir would produce a firm annual yield of 81,000 acre-feet and allow mining in the upper portion of the existing reservoir. The 81,000 acre-foot firm annual yield would maintain present benefits plus provide additional water. After mining, the gates would be lowered, raising the water level to 3,438 ft MSL which would produce a firm annual yield of 118,000 acre-feet.

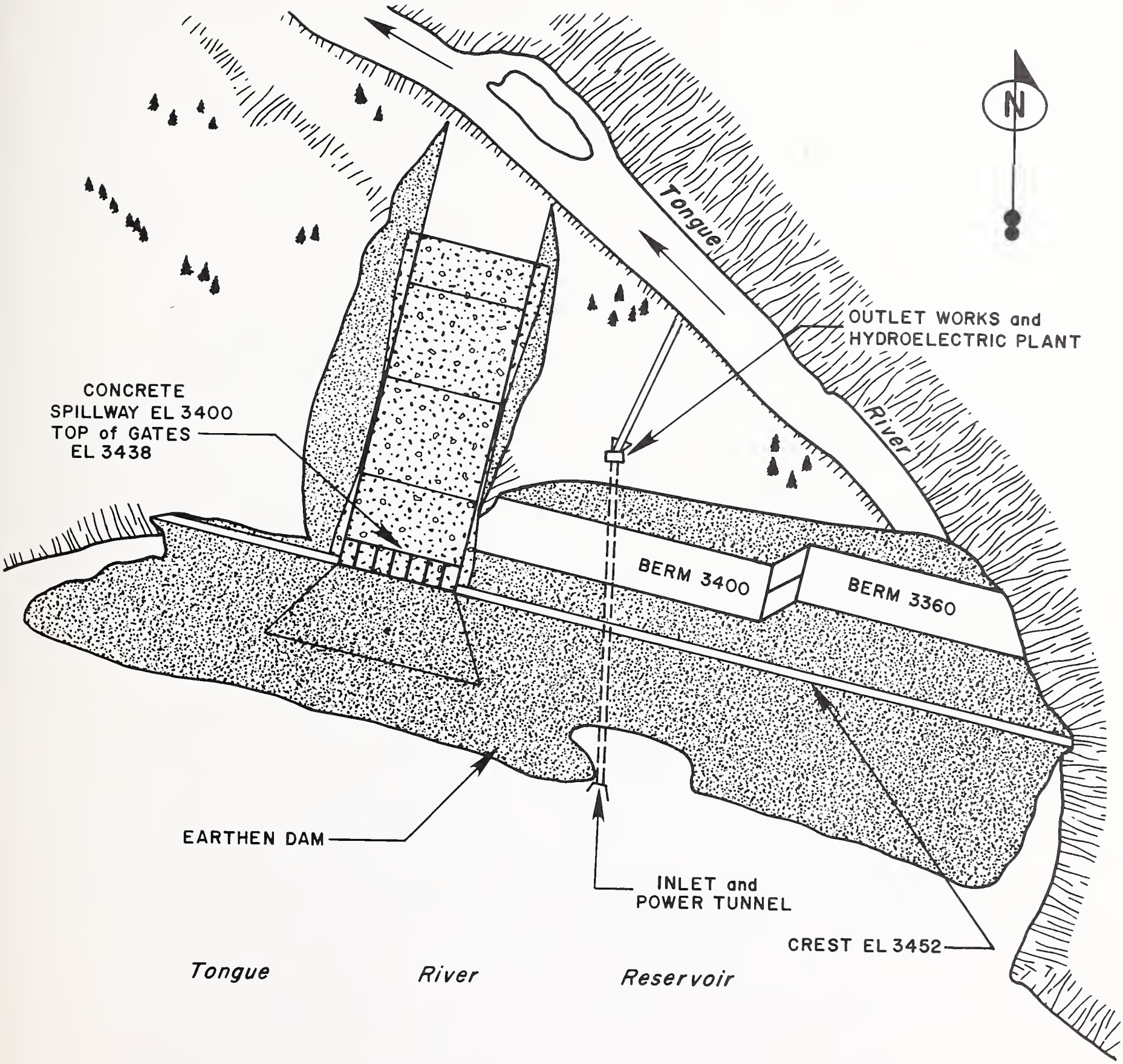


FIGURE 9

POST CREEK DAM, MINE COAL

Table 14. Pertinent physical data on the Post Creek alternative.

RESERVOIR	
Drainage area	1790 mi^2
Storage at spillway crest	223,000 acre-feet
Storage at top of embankment	285,000 acre-feet (est.)
Surface area at spillway crest	6,500 acres
SPILLWAY	
Type	Gated, concrete-lined, rectangular chute
Width	410 feet
Crest elevation	3,400 to 3,438 ft MSL
Capacity with water surface at 3,446.6 feet	522,000 cfs (est.)
OUTLET WORKS	
Inlet structure	Box type
Conduit	Combination concrete and steel
Capacity	3,000 cfs
EMBANKMENT	
Type	Zones earth-filled
Crest elevation	3,452 ft MSL
Freeboard above normal water surface	14 feet
Crest width	50 feet
Length	2,200 feet
Maximum height	150 feet

Like the upper portion of the current reservoir, large deposits of economically recoverable coal exist between the present site and the high Tongue dam site, with most of this coal between the Post Creek site and the high Tongue dam site. However, unlike the coal beneath the current reservoir, DNRC does not control any coal between the existing dam and the high Tongue dam site. Thus, the high Tongue dam alternative may require DNRC to pay for the coal between the sites, a costly feature leading to the second option at the high Tongue dam site.

This second option also calls for mining the coal between the sites. An emergency spillway placed at the present site would provide safety during mining of the river valley which should last about 12 years. Dam construction and mining activities could be scheduled to finish at the same time. The next phase of this option would then continue in the same manner as the first option, with an initial water level at the new dam of 3,400 ft MSL. Mining could then proceed in the upper portion of the present reservoir. Upon completion of this phase of the mining, the spillway gates would be lowered, raising the water level to 3,438 ft MSL which would allow a firm annual yield of 118,000 acre-feet. Tables 15 and 16 contain the schedule of key activities for the single-phase and two-phase mining options.

Table 15. Schedule for the high Tongue dam--single-phase mining.

YEARS	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05
Coal leasing package		X	X	X																						
Environmental studies & permits		X	X	X	X	X																				
Engineering design & studies		X	X	X	X	X	X	X	X	X																
Dam & spillway construction							X	X	X	X																
Coal mining											X	X	X	X	X	X	X	X	X	X	X					
Reservoir filling											X											X	X	X		

Table 16. Schedule for the high Tongue dam--two-phase mining.

YEARS	1980	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	11	12	13	14
Coal leasing package		X	X	X	X								X	X	X	X											
Environmental studies & permits		X	X	X	X	X	X						X	X	X	X											
Engineering design & studies		X	X	X	X	X	X	X	X							X	X	X	X	X	X	X					
Dam & spillway construction				X	X														X	X	X	X					
Coal mining											X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Reservoir filling																							X		X	X	X

DNRC's strategy on the high Tongue dam would assume starting with the two-phase mining option because of the possibility of having to acquire the coal between the dam sites. If DNRC could simply buy the surface rights and not mineral rights, the project would become the single-phase mining option. However, if purchasing the coal becomes necessary the first phase of the two-phase mining option would involve the mining of coal between the dam sites to recover the purchase cost. A significant portion of the coal between the dam sites is controlled by the federal government. With the possibility of mining, the federal government would probably retain its mineral rights and negotiate leases with a mining company. If DNRC could acquire all the coal, it could be leased in three years. Otherwise, federal leases could take four years.

Once the coal is leased, the mining company would take over the responsibilities of preparing a permit application. Concurrent with the coal leasing activities, DNRC would prepare permit applications and an EIS on the dam project. Although considerable engineering design and studies would be performed during this period, the major construction activity preceding the first mining phase would be the building of the emergency spillway at the present dam site. Presumably, the spillway construction could proceed prior to preparation of the final EIS and granting of the necessary permits for the high Tongue dam because of the urgency of the safety problem. Therefore, the schedule (table 16) has a two-year construction period subsequent to the completion of the environmental studies and permit procurement. The first phase of mining, scheduled to begin in 1990, allows for a six-year permit processing period starting from the time a mining company would acquire all the necessary leases.

The construction of the high Tongue dam would take four years with completion coinciding with the termination of the first phase of mining (2001). During the 12 years of mining between the dam sites, DNRC would seek leases for mining the coal in the reservoir, possibly requiring additional EIS work.

Upon completion of the first-phase mining and dam construction, the structure at the present site would be removed after transfer of the reservoir pool to the downstream site. At the downstream site, enough additional water could be stored to ensure a 81,000 acre-foot firm annual yield, while maintaining the reservoir level at 3,400 ft MSL. This additional water could probably be accumulated in one year.

DNRC expects the second phase of mining (in the upper part of what is the current reservoir) to take about 11 years. At the end of this phase of mining, the high Tongue dam spillway gates would be lowered, bringing the reservoir level up to 3,438 ft MSL. It would take about three years to store this additional water.

Under the single-phase option (which does not envision mining between the dam sites), the new dam could be constructed much earlier. In fact, without the complication of the first mining phase, the four-year construction period could commence in 1986. With the completion of construction in 1989, the reservoir would be transferred to the downstream site and the present structure would be removed. This would allow mining to proceed in the upper portion of the current reservoir beginning in 1990. At the conclusion of the 11-year period of mining in 2000, the reservoir would begin to store additional water. Within three years, the reservoir level would rise to a normal operating level of 3,438 ft MSL.

Figure 10 illustrates the dam envisioned at the high Tongue site, and table 17 summarizes pertinent physical data for both high Tongue dam options.

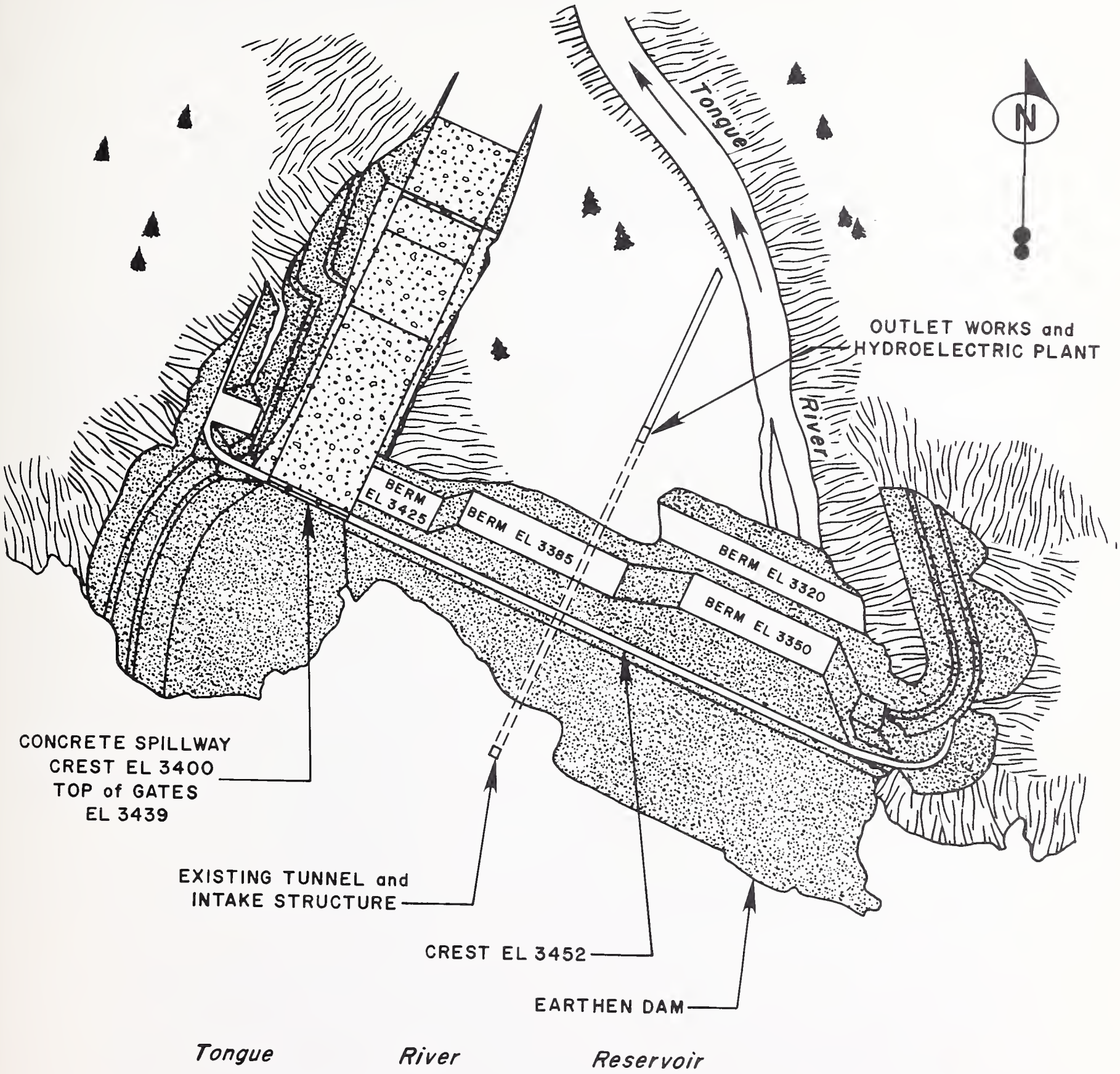


FIGURE 10

HIGH TONGUE DAM, MINE COAL

Table 17. Pertinent physical data on the alternatives at the high Tongue dam site.

RESERVOIR	
Drainage area	1,820 mi^2
Storage at spillway crest	320,000 acre-feet
Storage at top of embankment	390,000 acre-feet
Surface area at spillway crest	7,700 acres
SPILLWAY	
Type	Gated, concrete-lined rectangular chute
Width	410 feet
Crest elevation	3,400 ft MSL, gated to 3,438 ft MSL
Capacity with water surface at 3,446.6 ft MSL	520,000 cfs (est.)
OUTLET WORKS	
Inlet structure	Box type
Conduit	Concrete/steel combination
Capacity with gates open and water surface at 3,438 ft MSL	3,000 cfs
EMBANKMENT	
Type	Zones earth-filled
Crest elevation	3,446.6 ft MSL
Freeboard above normal water surface	8.6 feet
Crest Width	50 feet
Length	2,800 feet
Maximum height	180 feet

4. COMPARISON OF ALTERNATIVES

A. BENEFITS

As already noted, only the building alternatives preserve or enhance project benefits. The breaching alternative, although it would solve the safety problem, would eliminate these benefits and create a serious impact on the physical and socio-economic environment--perhaps as serious as the impact of project failure.

The present project has enhanced the physical and socio-economic environment of southeastern Montana. The project provides a reliable supply of irrigation water, with 36,000 acre-feet annually irrigating 18,500 acres. Farmers and ranchers who use the water from the reservoir have become dependent on this reliable, inexpensive water supply for economic competitiveness.

Another major benefit is recreation. In recent years with the increase in coal mining activities, water-based outdoor recreation such as fishing, boating, water skiing, and swimming has greatly increased. This recreational use should continue to increase as the area becomes more populated.

The water treatment plant that services the St. Labre Mission School and community obtains its water supply from the project and is to some extent dependent on the uniform flows the project provides.

The current project also supplies some industrial water. The Decker Coal Company uses 175 acre-feet, 750 acre-feet are used by the new Spring Creek Coal Mine, and until recently the Montana Power Company held an option for 4,000 acre-feet.

Another significant benefit of the project is the flood protection. By its very existence, the project provides flood control. High spring flows fill up the reservoir, thus reducing the magnitude of flooding downstream from the dam. Flood control can be enhanced by keeping the reservoir at a lower level, so there is more capacity to store large inflows. This attenuates the flows and passes downstream only a fraction, if any, of the peak inflow.

The project also provides the benefits of an enhanced aquatic and terrestrial habitat. The project has produced an unusual fishery, consisting of an abundance of diverse species that could not exist without the reservoir. In addition, the cold-water fishery directly below the project would not normally exist in southeastern Montana. The stabilized flows and the very existence of flow in the fall and winter months benefit the fishery far downstream. These flows have allowed the establishment of a riparian vegetation resulting in a more abundant and diverse group of aquatic and terrestrial creatures. The heron rookery in the upper portion of the reservoir is also an attribute of the project.

Associated with each building alternative is the installation of a hydroelectric facility. Thus, another project benefit is the production of electrical power. The development of hydropower is a national goal with the intent of decreasing dependency on foreign supplies of energy. Considering this national objective, coal mining associated with the project is also a benefit.

Another benefit of building alternatives may be the settlement of the Northern Cheyenne Tribe's water rights dispute. The building of a project which creates additional firm annual yield may encourage a negotiated settlement. Currently, the tribe purchases 7,500 acre-feet from the Tongue River Reservoir.

The alternatives discussed below provide these benefits to one degree or another.

1. Repair Tongue River Project

Repairing the existing structures would preserve the current benefits. In addition, this alternative could increase the firm annual yield 12,000 acre-feet by allowing the reservoir to be operated at its maximum level (3,424.4 ft MSL). Because of the unsafe condition and the desire of downstream residents to have additional flood control, the reservoir is currently operated well below the maximum level. However, with the elimination of the safety problem, the reservoir could be operated at a higher level and provide additional firm annual yield. This extra water supply would, of course, be at the expense of some of the current flood control. Furthermore, the additional 12,000 acre-feet firm annual yield would not meet all indicated future demand. As a part of the Yellowstone reservation process, DNRC was granted a reservation on the Tongue, in part to provide future irrigation supply (20,900 acre-feet) to three conservation districts (Big Horn, Rosebud and North Custer) and the Department of State Lands. In addition, the Northern Cheyenne Tribe apparently expects more than 12,000 acre-feet firm annual yield as part of its settlement.

Currently, the surface area of the reservoir averages about 3,300 acres during the summer months of peak utilization. By operating the reservoir at its maximum level, this would be increased to about 3,500 acres. Operation of the reservoir at a lowered level results in a significant drawdown by the end of the irrigation season in years of below average stream flows. In 1980, for example, the reservoir was drawn down to about 3,400 ft MSL (1,200 acres) by September. This adversely impacts the aquatic species and the shoreline vegetation--a situation that this alternative would make less severe.

The cold-water fishery directly below the dam should not be affected by operating the project at a higher water level. However, recreational pursuits relating to stabilized flows may be affected by a higher operating level. This stems from the fact that flow regulation results from flood control. Therefore, since this alternative reduces flood control, it also reduces flow regulation to some extent.

A number of sport fishes including sauger and paddlefish move from the Yellowstone River into the lower Tongue River during the high spring flow period to spawn. A major reduction of flow during this period would impair the ability of the fish to move up into the lower Tongue River.

By its very existence, the project provides downstream flood control. The reservoir fills during the spring high flow period when most flooding occurs.

Part of this natural flood control comes from surcharge, which is the volume available for storage between the spillway crest elevation and the dam embankment crest elevation. This surcharge attenuates a large peak inflow producing a reduced peak outflow of longer duration. Operating the reservoir at a less than maximum level enhances flood control by creating additional surcharge (i.e., flood storage) which can store more water in the event of a flood.

The repair alternative would include the installation of a two-unit, 1.95-MW hydroelectric plant capable of annually supplying approximately 6.9 million kWh. This power would be generated primarily during the irrigation season and could be made available for irrigation-related activities such as pump diversions and sprinklers. Application of this energy for sprinklers could irrigate from 3,000 to 9,000 acres.

Approximately 47.7 million tons of economically recoverable coal underlie the upper end of the current reservoir. After an initial year of start-up (2.7 million tons), a 4.5-million-ton-per-year production rate could be established using conventional mining methods for 11 years. However, the mining option of this alternative may draw the reservoir down to a lower level than current operation for as much as 15 years.

The lowered level would be facilitated by the use of a spillway with crest elevation at 3,400 ft MSL which would reduce the firm annual yield to 14,500 acre-feet, well below a level needed to meet the current water contracts. In other words, the project would fall short of fully supplying current users in low flow years. After mining ends, however, the reservoir water level would be raised by building the spillway crest elevation up to 3,424.4 ft MSL, high enough to produce a firm annual yield of 52,000 acre-feet, slightly more than needed to satisfy all current contracts.

2. Enlargement of Tongue River Project at the Present Site

Enlargement of the Tongue River Project at the present site would create a reservoir capable of providing a firm annual yield of 82,000 acre-feet, 42,000 acre-feet more than the current firm annual yield. Thus, this alternative would not only preserve existing benefits, but it would more than double the water supply. This additional water supply should be more than sufficient to settle the tribal water rights dispute. However, there may not be enough additional water to fully satisfy the reservations granted to DNRC for the three conservation districts and the Department of State Lands (20,900 acre-feet), nor enough for industrial users.

The larger project would, of course, provide more flood control both because of the larger volume for catching spring inflows and because of the increase in surcharge associated with the larger project. The firm annual yield of 82,000 acre-feet assumes no operational flood control benefits, but reducing the firm annual yield could make additional flood control possible.

This alternative, at 3,438 ft MSL, would create a 5,000-acre reservoir. A larger reservoir should benefit recreation--at least in the amount of surface area available--and have at least a neutral and possibly beneficial impact on

the cold-water fishery below the dam. A larger project could also stabilize flows downstream to a greater extent which could further establish riparian vegetation. However, more stabilized flows may significantly reduce high spring flows, and thus reduce the extent of flushing of the stream, a necessary cleansing action. In addition, significantly reduced spring flow may hinder the ability of spawning fish moving up the lower Tongue River from the Yellowstone River.

Initially, the project would inundate shoreline vegetation, thereby destroying wildlife habitat. However, a new shoreline habitat would be established. Current backwater areas (i.e. these areas inundated only during the high spring water level) would be affected similarly--the possible exception being the rookery at the upper end of the reservoir. The rookery is not a stable habitat, with the seasonally flooded nesting trees either dead or dying. By increasing the water level, these trees would be more often inundated, thereby enhancing the deterioration and the ultimate demise of the rookery.

This alternative would include a two-unit, 2.6-MW hydroelectric plant capable of supplying 10.2 million kWh per year, the majority generated during the irrigation season. Depending on the type of sprinkler application, this amount of energy could be used to irrigate from 5,000 to 13,000 acres.

As with the repair alternative, there is the possibility of mining an estimated 47.7 million tons of economically recoverable coal beneath the upper portion of the reservoir. However, in this case, the lower level necessary during mining would be provided by a 3,400 ft MSL spillway with radial gates that could bring the water level up to 3,438 ft MSL after mining concludes. During mining, the reservoir would provide only a firm annual yield of 14,500 acre-feet, not enough to meet current contracts.

A gated spillway has a major drawback relating to flood control. To provide for the safety of the project, the spillway must be operated never to allow water to flow over the top of the gates. When the reservoir is full, the gates must be raised to match the outflow to the inflow. This kind of operation reduces the project's flood control, since, with a full reservoir, floods are just passed downstream with little attenuation.

3. Post Creek Site

Building a new dam at the Post Creek site would ultimately produce a reservoir capable of supplying a firm annual yield of 106,000 acre-feet. This 66,000 acre-foot increased supply should be enough to settle the tribal water rights dispute and satisfy future agricultural demands (the reservations granted DNRC for the three conservation districts and to the Department of State Lands) with some left over for industrial use.

This alternative includes mining of the coal underlying the present reservoir, so initially the water level would be maintained at 3,400 ft MSL, producing a firm annual yield of 46,000 acre-feet--enough to satisfy current contracts with additional water for the tribe, agriculture, or industry.

This alternative could also provide enhanced flood protection of the downstream area if some of the large firm annual yield (106,000 acre-feet) were sacrificed for operational flood control. Since the identified future demands are less than 106,000 acre-feet, the reservoir could be operated at a level lower than

3,438 ft MSL, establishing flood storage capable of storing unusually high inflows and thereby reducing downstream flooding. This may compensate for the reduced flood control inherent in the use of a gated spillway.

When fully operational, this project would create a 6,500-acre reservoir. This additional surface area and shoreline would increase recreational opportunity. However, the larger reservoir may significantly reduce high spring flows which both flush out the lower river channel and facilitate spring spawning runs from the Yellowstone River. In addition, this alternative would inundate much of what now constitutes the cold-water fishery below the project, but a new cold-water fishery would most likely be established below the new project.

The area to be newly inundated currently serves as a wintering area for deer. Although a similar habitat may be established below the new project, the overall impact on the local deer population would be negative because of reduced habitat. The increased water level may also accelerate the deterioration of the rookery.

This alternative includes the installation of a two-unit, 4.7-MW hydroelectric plant capable of supplying 6.8 million kWh per year during the mining phase and 17.75 million kWh per year when fully operational. Using part of the storage capability for flood control would reduce the electrical yield.

The Post Creek alternative would also allow the recovery of the estimated 47.7 million tons of coal from beneath the upper portion of the present reservoir.

4. High Tongue Dam Site

Building the high Tongue dam would create a reservoir with a firm annual yield of 118,000 acre-feet, 78,000 acre-feet more than the present reservoir. This additional supply should assist in settling the tribal water rights dispute on the Tongue River, satisfy future agricultural demands (reservations granted DNRC), and provide water for industry.

As previously discussed, this alternative has two options--both involving mining coal beneath the upper portion of the present reservoir. In addition, one of the options (the two-phase mining) calls for mining coal between the present site and the high Tongue dam site. Under this option, the present reservoir would be maintained by constructing an emergency spillway at the present site. During the 12 years of mining between the two sites, only the present water supply (40,000 acre-feet) would be available. With the completion of mining between the two sites and construction of the high Tongue dam, a new reservoir with a water level of 3,400 ft MSL, providing a firm annual yield of 81,000 acre-feet would be available, while the coal beneath the present reservoir was mined.

The other option (single-phase) does not contemplate mining the coal between the two sites, only beneath the present reservoir. Under this option, 81,000 acre-feet would be available as soon as the high Tongue dam was constructed. For either option upon completion of the mining in the present reservoir, the water level would be raised to 3,438 ft MSL, increasing the firm annual yield to 118,000 acre-feet.

The intermediate 81,000 acre-foot supply would accommodate existing uses. In addition, there would probably be enough excess water to help in settling the

tribal water rights dispute and provide some additional agricultural and industrial water.

This alternative could enhance flood protection for the downstream area if some of the firm annual yield (118,000 acre-feet) were sacrificed for operational flood control. Since the identified future demands are for less than 118,000 acre-feet, the reservoir could be operated below 3,438 ft MSL, establishing flood storage capable of storing unusually high inflows and thereby reducing downstream flooding. This may compensate for the reduced flood control inherent in the use of a gated spillway.

When fully operational, this alternative would create an 8,000-acre reservoir with additional shoreline, which should increase recreational opportunity. However, the larger reservoir may significantly reduce high spring flows which both flush out the lower river channel and facilitate spring spawning runs from the Yellowstone River. This alternative would inundate much of what now constitutes the cold-water fishery below the project, but a new cold-water fishery would most likely be established below the new project.

The area to be newly inundated currently serves as a wintering area for deer. Although a similar habitat may be established below the new project, the overall impact on the local deer population would be negative because of reduced habitat. The increased water level may also accelerate the deterioration of the rookery.

This alternative also includes the installation of a two-unit, 6.6-MW hydroelectric plant capable of supplying 13.79 million kWh per year during the mining phase and the 26.25 million kWh per year when fully operational. Lowering the reservoir for operational flood control would reduce the electrical yield.

This alternative would allow the recovery of the estimated 47.7 million tons of coal from beneath the present reservoir and an estimated 81.2 million tons of coal between the high Tongue dam site and the present site.

B. SOURCES OF REVENUE

Table 18 summarizes the present value of direct project revenues from 1980 through 2030 using a 10 percent discount rate. The Montana Power Company's option on 4,000 acre-feet is included here as a current industrial water sale.

1. Current Agricultural Water Sales

The project currently provides about 36,000 acre-feet for agricultural use. Of this amount, 7,500 acre-feet is allocated to the Northern Cheyenne Tribe and about 5,290 acre-feet is distributed by the Tongue and Yellowstone Irrigation District.

All revenue from the sale of this agricultural water is governed by the 1969 updated water marketing agreement between the Montana Water Conservation Board (now handled by DNRC) and TRWUA.

The original contract between TRWUA and the Montana Water Conservation Board, a predecessor of the Board of Natural Resources and Conservation, obligated the

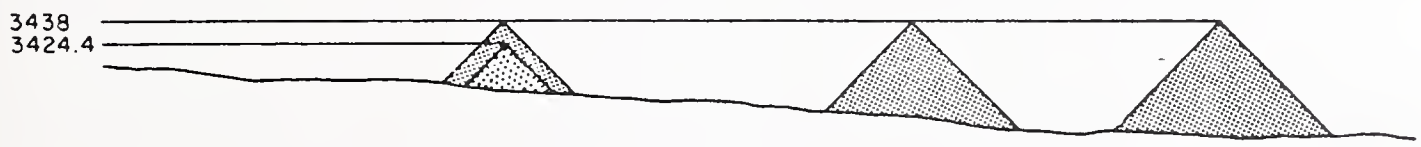
Board to provide 32,000 acre-feet to TRWUA which, in turn, was required to pay $41,600 per year through 1975, resulting in an annual price of $1.30 per acre-foot, in addition to fees for operation and maintenance.

The 1980 income from current agricultural water sales was about $37,000, reflecting the fact that a number of the water purchase contracts have been paid off, including the Northern Cheyenne Tribe. Revenue from the current agricultural contracts would end in 2008, when the last of the water purchase contracts is paid off.

The analysis of the alternatives assumes all current agricultural use would be priced at a 1980 dollar cost of $3 per acre-foot escalated at 8 percent per annum. This rate would take effect as soon as the current supply could be produced safely and would extend to 1998 when the escalation would terminate. For those alternatives involving mining and construction at the present site, it is assumed that revenue from current agricultural water sales would be reduced by two-thirds during mining due to the reduced water level.

Table 18. Present value of direct project revenue (in thousands of dollars).

TONGUE DAM ALTERNATIVES



	Repair Existing Dam		Enlarge Existing Dam		Post Creek Dam	High Tongue Dam		Breach Dam
	No mining	Mine existing reservoir	No mining	Mine existing reservoir	Mine existing reservoir	Mine existing reservoir	Mine existing Reservoir and downstream	
Water Sales								
Existing Agriculture	2,374	891	1,991	891	1,900	1,900	2,085	84
Existing Industry	63,101	50,752	59,976	50,752	59,193	59,193	60,758	
New Agriculture	0	0	1,015	559	891	1,181	588	
New Industry	0	0	0	0	100,800	160,000	146,600	
Coal Royalties								
Surface	0	780	0	780	780	780	5,970	
Mineral	0	23,397	0	23,397	23,397	23,397	15,696	
Hydroelectric	8,653	5,159	10,865	7,569	14,701	22,912	15,389	
Land Sales								6,547
Total Revenue	74,128	80,979	73,847	83,948	201,659	269,363	247,086	6,631

Note: Present Value of Project and Revenues were determined using a 10 percent discount rate and a period from 1980 through 2030.

2. Future Agricultural Water Sales

Given the present unsafe condition of the project, there is no additional water for future agricultural use. With the exception of the breach alternative, all options could make some additional water available for future agricultural use. However, the additional water from alternatives that do not provide more storage capacity may not be available to nontribal users. Thus, only those alternatives which involve an increase in the storage capacity would result in future agriculture sales.

As previously mentioned the Board of Natural Resources and Conservation granted the DNRC a reservation on the Tongue for a larger project with the stipulation that DNRC provide the water requested (20,900 acre-feet) by three conservation districts and the Department of State Lands.

Subsequent to the Board's directions, the question of federal reserved rights, specifically for the Northern Cheyenne Tribe, has arisen. The outcome of the negotiations (i.e. the quantity of water on which a settlement is reached) may have a significant impact on the ability to supply water for future nontribal irrigation. DNRC used 35,000 acre-feet as a rough estimate of the amount of water needed for a tribal settlement. In alternatives where additional water was available over the 40,000 acre-feet currently in use and the estimated tribal settlement of 35,000 acre-feet, the additional water was first allocated to new agriculture up to 20,900 acre-feet. For example, in the three alternatives which increase the firm annual yield to 82,000, 106,000, and 118,000 acre-feet, respectively, there would be 14,500, 20,900, and 20,900 acre-feet, respectively, for future agriculture.

The amount of revenue that could be generated from future agricultural water is not known. Some economic studies have indicated that irrigation water used primarily for hay production could be priced up to $20 per acre-foot (Long, 1977). However, between 1971 and about 1976, additional irrigation water was available from the Tongue River Project at $2.50 per acre-foot, and no additional water has been marketed. For the analyses conducted on the various alternatives for which new agricultural water was available, a 1980-dollar value of $3 per acre-foot escalated at 8 percent per annum was used.

3. Current Industrial Water Sales

The project currently provides 925 acre-feet for industrial use. Until recently, the Montana Power Company has held an option for another 3,250 acre-feet. In addition, the St. Labre Mission uses 50 acre-feet for municipal purposes, and the US Fish and Wildlife Service uses 650 acre-feet for its fish hatchery and rearing facilities near Miles City.

The sale of water to the St. Labre Mission and the US Fish and Wildlife Service is governed by the three-party water purchase contracts used by TRWUA for agricultural water sales. The industrial water marketing contract with Decker Coal Company and the Spring Creek mine, unlike the agricultural water marketing contract, allows DNRC to exculpate itself from supplying the contracted amount of water when a water shortage exists due to a drought or uncontrollable forces. The contract defines uncontrollable forces to include failure of the facilities.

The price of water for the St. Labre Mission and the US Fish and Wildlife Service is $1.30 per acre-foot. The Montana Power Company option was for $5 per acre-foot, the Decker Coal Company pays $25 per acre-foot and Spring Creek pays $30 per acre-foot. Like the current agricultural water sales revenue, there is a 37-year payment provision in the St. Labre and the US Fish and Wildlife Service contracts, after which they would not generate any revenue. The revenue from St. Labre would terminate in 1991, and from the US Fish and Wildlife Service in 1997. In determining future revenue from these sources, they were treated as current agriculture at $3.00 per acre-foot escalated at 8 percent per annum. The 4,175 acre-feet of industrial water was priced at a 1980 dollar cost of $200 per acre-foot (DNRC 1974) escalated at 10 percent per annum.* Like the rate for current agricultural water, this rate would take effect as soon as a safe supply could be provided and would extend to 1998 when the escalation would terminate.

4. Future Industrial Water Sales

Because of the unsafe conditions, the project is being operated to fulfill only current contracts and thus provide no additional water for future industrial use. Only construction alternatives which produce additional water over current uses, tribal settlement, and new agriculture would make water available for future industrial use. Thus only for the alternatives at the new downstream sites (Post Creek and high Tongue dam) would future industrial water be available. In these two alternatives (which provide firm annual yields of 106,000 and 118,000 acre-feet respectively), there would be 17,600 and 29,600 acre-feet available, respectively, for future industrial use. The most probable industrial uses of stored water in the region would be for coal gasification, coal liquefaction, coal-fired electrical generation, and possibly coal slurry.

Both coal gasification and liquefaction would use water as an input into the chemical process in addition to consuming water for cooling purposes. Several different types of technologies would be available in the production of synthetic natural gas and syncrude, and each process would have different water requirements. Two basic types of cooling methods would also be available, so the water requirements of these plants could vary.

Coal-fired generating plants use water mostly for cooling purposes. Three types of cooling could be used: once-through cooling, evaporative wet cooling, and dry cooling. Once-through cooling may be impractical unless plants were located adjacent to the Tongue River Reservoir or to the river below the project. Although the depletion for once-through cooling is relatively small, the diversion requirements would be much higher than for the other methods.

Coal slurry pipeline processes would mix equal proportions by weight of dry pulverized coal and water prior to pumping the mixture to the destination.

Table 19 lists the range of water use by each type of plant that could possibly locate in the area. The figures for gasification and liquefaction are estimates because no such plants are in operation.

Table 19. Water requirements for likely industrial uses (acre-feet per year).

Industrial Use	Capacity	Diversion	Depletion	Diversion	Depletion	Diversion	Depletion
		High		Average		Low	
Liquefaction	50,000 bbl/day[1]	26,390	26,290	7,800	6,000	3,998	3,998
High BTU gasification	250 MMCFD[2]	19,154	12,492	11,500	9,806	2,608	2,608
Generation	1000 megawatts	not available		15,000	15,000	not available	
Coal slurry	18 million tons/y[3]	not available		10,000	10,000	not available	
Coal mining	10 million tons/y	not available		200		not available	

1. Barrels per day
2. Million cubic feet per day
3. Assumes coal is 24 percent water

Sources: U.S. Department of Energy, 1978; Harza, 1976.

* The calculations for current industrial revenue were made before the Montana Power Company terminated its option.

The revenue that could be generated from new industrial water sales is not known. However, the 1979 DNRC report to the Montana legislature concerning the Tongue River Project indicated that the Tongue River Reservoir market area was fairly well constrained by the availability of low-priced industrial water stored in Yellowtail on the Bighorn River. At a storage cost of $200 per acre-foot, the market area generally encompasses only the Tongue River drainage down to a point just north of Ashland.

As a part of the 1979 DNRC study, 43 potential industrial customers were contacted as to their interest in purchasing stored water from a larger Tongue River Project. Company representatives indicated that $200 per acre-foot was a reasonable price and within their ability to pay. Those companies interested in coal slurry pipelines showed the most interest, since currently there appears to be sufficient economic demand. However, this would require a change in Montana statutes which prohibit the use of water for exporting coal slurry. Coal gasification and liquefaction are currently uneconomical and their development in the near future is uncertain. From the date a decision is made to construct a coal conversion plant, it would be at least 10 years before the water supply would be needed. Thus, the use of water for industrial purposes from a new Tongue River Project, at least in the near future, is not promising.

The analyses of alternatives which provided enough water for future industrial use were performed with and without industrial water sales. When industrial water sales were included, the price was assumed to be a 1980 dollar cost of $200 per acre-foot escalated at 10 percent per annum.

5. Hydropower

All construction alternatives contemplate the installation of hydroelectric facilities. The current costs of these facilities range from $4.5 to $7.1 million (in 1980 dollars). Revenues generated by the facilities were based on a 1980 dollar price rate of 30 mills per kWh, which is consistent with current prices, and inflated at 10.3 percent per annum. In addition, five- to six-year service contracts were assumed based on present pricing contracts during which the rate would be held constant. During periods of mining or filling when the reservoir level was below the operating level, the hydroplant's production would be reduced accordingly.

6. Coal

Resource Evaluation

Mineable coal exists in two areas associated with the Tongue River Project--beneath the upper portion of the present reservoir and beneath the river valley between the present dam site and the high Tongue dam site. Recoverable coal reserves (that part of the identified coal resource that can be economically mined) of 47.7 million tons and 81.2 million tons exist in the upper reservoir and in the river valley, respectively. DNRC controls an estimated 34.3 million tons of recoverable coal in the upper reservoir but none in the river valley.

Mining of the coal in the upper reservoir would entitle DNRC to mineral lease royalties. Currently, lease royalties are 12.5 percent of the contract sales price of the coal--$9 per ton in 1980 in the Decker area. Thus, the mineral lease royalties DNRC could expect from the mining of coal in the upper reservoir are $38.6 million (12.5 percent x $9/ton x 34.3 million tons) in 1980 dollars.

In addition to the mineral lease royalties on the coal controlled by DNRC, surface lease royalties may be expected from federal and fee coal (privately owned) since DNRC controls the surface above this coal. It is not customary to charge for both surface and mineral lease royalties when one entity controls both. Surface lease royalties are assumed to be 10 percent of mineral lease royalties. Thus, in the upper reservoir, surface lease royalties to DNRC would amount to $1,300,000. Under the two-phase mining option of the high Tongue dam alternative, the area between the two sites would have to be purchased by DNRC for the reservoir anyway. Although DNRC would probably not receive the mineral rights to federal coal and possibly not even fee coal, it would be entitled to surface lease royalties if the coal were mined. Surface lease royalties to DNRC in the river valley below the project could amount to about $9.1 million in 1980 dollars. For this option, it was assumed that DNRC would have to pay an inflated price for the land between the two sites because of the coal, but not for the coal itself. DNRC would then seek to recover the land costs from the surface lease royalties.

Under those alternatives which envision coal mining, only in the upper reservoir, DNRC could expect coal revenues of about $39.9 million. The two-phase mining option of the high Tongue dam alternative (which also contemplates mining of the river valley) would produce about $49 million in coal revenue to DNRC. All these values are in 1980 dollars. For any of the mining options, however, revenues would not begin until 1990. For use in this study, the contract sale price of coal was assumed to escalate at the historical rate of 6.4 percent per annum. (See The Appendixes to the Tongue River Rehabilitation Project under another cover.)

Mining of this coal produces another substantial source of revenue to the State of Montana--coal severance tax and resource indemnity tax. Whether these tax revenues could be considered project revenues seems to hinge on the question of whether the proposed mining would be in addition to or in replacement of other mining in the state. If the coal mining in the two areas could be considered additional and the tax revenue attributable to the project, then the state could expect about 130 million 1980 dollars from mining of the upper reservoir and about 220 million 1980 dollars from mining in the river valley.

It may be possible to justify channelling directly to the project coal-related tax revenues which are attributable to the project by arguing that the mining and related taxes are additional to what the state would otherwise have. As suggested by those familiar with coal mining, however the mining must generally involve a new mine to be additional. If the mining is part of an existing mine, the mining would most likely replace the mining in another area. To initiate a new mine, it generally requires at least 100 million tons of recoverable coal. Thus, the mining of the upper reservoir alone would not constitute a new mine and would most likely not produce additional coal. Only the alternative that contemplates mining of both areas could support a new mine. However, the legislature may still not consider this mining additional and even if the mining were considered additional, that would not necessarily convince the legislature to count coal tax revenues as project revenues. For this reason, DNRC has not counted coal tax revenues as project revenues.

Impact on Construction Costs, Water Sales, and Hydropower Revenue

Costs increase substantially with time. Coal mining alternatives require some construction to be delayed until after mining. In addition, coal mining

alternatives require a modification in construction not needed in the no-mining alternatives. In most cases, mining alternatives require a gated and much larger concrete spillway, capable of handling the entire PMF. This is a more expensive configuration than a small service spillway and an earthen auxiliary spillway. Gated spillways would be needed to maintain the lower water elevation to allow mining. In addition, the spillway would have to be large enough to provide for the PMF during mining. Alternatives with larger gated spillways cost approximately $30 million more than alternatives without them. Since DNRC would be able to expect approximately a maximum of $40 million in project-related coal revenues from alternatives that include only mining under the upper reservoir, the economic incentive for mining is severely eroded.

During mining, water levels must be lowered which substantially reduces revenue from water and hydropower sales. In some alternatives, revenue is nonexistent until mining is completed. For the enlarging of the existing project, the mining alternative puts off full water and hydropower sales until 2001. In the no-mining alternative, full development begins in 1989. This amounts to an estimated $16.2 million loss of water and power revenue (1980 dollars). This coupled with the $30 million increase in construction costs for the mining alternative (to pay for gated spillway) favors the no-mining alternative.

Another additional cost of mining alternatives is coal leasing expenses. More drilling would be needed to evaluate the quality and quantity of the coal resource. Because the state's schedule for leasing would precede the federal government's, the state's leasing package would require the equivalent of a federal resource management plan to ensure that the federal coal could be leased at the same time as state coal.

Social and Environmental Impacts

Aside from apparent negative economic aspects, there are several possibly adverse social and environmental impacts that may preclude mining alternatives. Paramount among the social impacts is the approximately 11 to 15-year disruption of the present water supply caused by mining alternatives at the present site. In addition, the increased emphasis on mining has already significantly disrupted rural life styles in the area.

Although current regulations do not specifically preclude coal mining in an alluvial valley floor, certain assurances concerning the maintenance and reestablishment of existing hydrology must be satisfactorily demonstrated before a mining permit may be issued. The two mining areas are within the Tongue River's alluvial valley floor. However, the project will result in the establishment of a reservoir which will change the hydrology. This may dismiss the alluvial valley floor issue.

Other environmental issues include water quality impacts during and after mining and the destruction of the cormorant and heron rookeries in the upper portion of the existing reservoir. Of major concern to water quality is the possibility of the leaching of undesirable and caustic minerals from the overburden exposed during mining. If mining would result in degrading the water to the point that existing uses were adversely affected either during or after mining, then mining would not be allowed. Although the rookeries in the upper portion of the present reservoir will eventually disappear as the trees rot from the standing water, the ecological impacts of this accelerated destruction caused by mining are unclear.

Thus, it is uncertain whether a mining company could obtain a mining permit for either area. In fact, a number of representatives of the mining industry indicated that without the state's assurance of a mining permit they would be reluctant to even lease the coal.

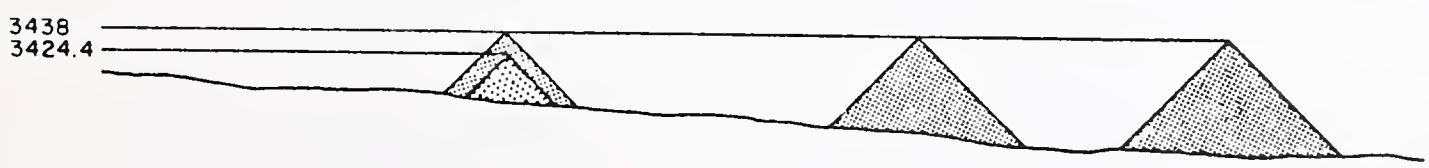
Without the dedication of coal tax revenues to the project and the assurance of a mining permit, the mining alternatives are not attractive. At least in the near future, these conditions would most likely not be met. Therefore, DNRC has dropped the mining alternatives from serious consideration.

C. COSTS

Costs associated with large projects such as the Tongue River Project include feasibility and environmental studies, land acquisition, engineering and construction, financing, operation, maintenance and repair and project management. Table 20 gives comparison of these costs for each alternative. For the breach option, engineering and construction costs refer to removal of the present structure and reclamation of the presently flooded area.

There is also a cost associated with the time value of money. All the costs to be incurred for a project cannot be made in a single year. Some of the costs will be incurred at later times (e.g., construction). The later the date, the more the project would cost. This is due to escalation in costs. Accordingly, although the figures in table 20 are suitable for comparison between alternatives, these are not the real costs. For example, the no-mining option of the repair alternative has a 1980-dollar engineering and construction cost estimate of $66,520,000 (column 1, table 20). However, construction would not begin until 1983 and, in 1983, the construction costs would be more like $86,145,000. So, the cost of waiting is of considerable importance. These costs plus the cost of having to borrow money (i.e., interest and finance charges) are reflected in the cost item called financing.

Table 20. Summary of Project Costs (1980 dollars).



	Repair Existing Dam		Enlarge Existing Dam		Post Creek Dam	High Tongue Dam		Breach Dam
COSTS	No Mining	Mine existing reservoir	No Mining	Mine existing reservoir	Mine existing reservoir	Mine existing reservoir	Mine Downstream and existing reservoir	
Project Management	5,682,000	5,882,000	6,332,000	7,757,000	7,957,000	7,957,000	10,207,000	300,000
Preliminary Activities	100,000	760,000	515,000	1,125,000	1,205,000	1,205,000	2,533,000	105,000
Engineering and Construction	66,520,000	101,143,000	70,308,000	103,668,000	151,507,000	170,899,000	195,163,000	9,311,000
Land	-0-	4,406,000	5,666,000	2,066,000	6,386,000	9,026,000	9,026,000	N/A
OM & R	10,120,000	9,900,000	7,181,000	10,584,000	15,498,000	18,204,000	14,576,000	N/A
Project Cost	82,422,000	122,091,000	90,002,000	125,200,000	182,553,000	207,291,000	231,505,000	9,716,000
Financing	56,900,000	75,800,000	64,600,000	81,020,000	123,000,000	134,000,000	155,000,000	3,440,000
Gross Cost	139,322,000	197,891,000	154,602,000	206,220,000	305,553,000	341,291,000	386,505,000	13,156,000

Notes: 1. For all alternatives, except breach, management and OM & R costs were considered from 1980 through 2030.
2. Preliminary activities include EIS, permits and coal leasing expenses.
3. Financing costs include issuance expenses and interest payments.

1. Project Management

Project management costs were developed from estimates of staff requirements and associated expenses. A full staff (a senior engineer, two technical assistants, and clerical support) would be needed during the preconstruction activities. However, after construction begins, the senior engineer and probably about half the associated expenses could be dropped due to engineering management cost included in the engineering and construction cost estimates.

2. Preliminary Activities

Preliminary activities refer to studies needed prior to engineering design and construction, such as the EIS study, permit procurement, and coal leasing costs. The costs of the EIS and permit procurement were based on the Montana Environmental Policy Act fee schedule and the estimated significance of environmental disruption of the project. Coal leasing costs (mining options only) would occur from exploration, coal resource evaluation, and lease preparation. Those alternatives which include only mining in the upper portion of the present reservoir require minor additional exploration and evaluation expense. However, the mining of the river valley between the present site and the high Tongue dam site requires an extensive amount of exploratory drilling and resource evaluation. The costs of lease preparation were estimated by using similar costs incurred by energy companies for similar work.

3. Engineering and Construction

Some engineering costs are for preliminary activities such as feasibility and geotechnical studies. Engineering work must also be provided for the EIS, and this preliminary work would not necessarily be used in the final design.

Costs estimates of geotechnical studies and surveying were based on man-hour and drilling estimates for the various alternatives presented by R.C. Harlan and Associates in their 1977 report. The unit costs from those estimates were updated to 1980 price levels and then applied to the various alternatives of this study on the basis of extent of work required for the various sites and reservoir levels.

Cost estimates for feasibility studies were based on 1980 engineering salary levels using specific man-month estimates for each class of work needed for each alternative.

Design engineering, the preparation of plans and specifications, and engineering during construction were estimated using fee versus construction-cost curves published by the American Society of Civil Engineers (1972). Curve B for projects of average complexity was used for the high Tongue dam options. These values were then adjusted downward because substantial engineering work has already been completed (Bechtel, 1969). Curve A for projects of above-average complexity was used for the other alternative.

For management of construction, which includes all inspection and testing, specific estimates were made depending on the length of construction time and size and complexity of each alternative.

For hydroplant engineering, an allowance of 8 percent of construction cost was made for design engineering and engineering during construction, and 12 percent for management of construction.

The construction cost estimates were based on specific estimates of key quantities for each element of each alternative such as spillway excavation, spillway concrete, dam embankment, etc. For the Harlan 1977 report, detailed construction plant, equipment and labor element were developed and priced. Unit-direct construction costs of significant items of work for the high Tongue dam were developed and overhead, profit, and bonding costs were added. The total costs thus developed in 1977 were updated to 1980 for the present study. These unit costs were applied to the specific quantity estimates described above and total construction costs obtained for each significant item of work.

Table 21 displays the itemized cost of the various construction activities by alternative. The associated engineering costs are also included. A contingency allowance of 35 percent was used at the Post Creek site, 25 percent at the existing site and 20 percent at the high Tongue dam site. The relatively high contingency for the Post Creek site reflects the lack of geotechnical, topographic, and other engineering data which means there are more unknown factors at Post Creek than at the other sites. The disparity between the contingency for the existing site and the high Tongue dam site stems from experience which indicates there are generally more unknowns at the feasibility stage for raising an existing dam than for new construction.

The hydroelectric plant costs shown on table 21 for the various alternatives include the construction, engineering and contingency costs.

4. Land

Some alternatives require the acquisition of land for increased reservoir size and location of embankment, spillway, and outlet works. The land acquisition process would probably begin prior to construction, but not all land need be acquired prior to construction.

At an elevation of 3,438 ft MSL, the two options at the high Tongue dam site would flood 8,900 acres, the alternative at the Post Creek site would flood 6,800 acres, and the enlarging alternative at the present site would flood 6,000 acres. At maximum elevation, the current reservoir would flood an area of about 4,850 acres. However, the state acquired excess acreage--approximately 5,820 acres in all for the present project. Consideration of the maximum flooded area versus the acquired area gives an acquisition factor of 1.2 (i.e. 5,820 acres ÷ 4,850 acres = 1.2). Applying this factor to the high Tongue dam site (8,900 acres) yields an estimated 10,680 acres. This is an additional 4,860 acres more than the 5,820 acres the state has. Similarly, the enlarging alternatives at the Post Creek site and the present site would require purchase of an estimated additional 3,530 acres and 1,380 acres respectively. For the repair alternative, the mining option would require an estimated 2,940 additional acres whereas the no-mining option would require no additional acres.

Land costs were estimated using the information presented in an appraisal that was prepared in conjunction with the Pacific Power and Light acquisition of land from DNRC for the Spring Creek Mine Railroad Spur (Howe, 1979). The appraisal included examples of land recently sold in the area. Based on these examples an average value of $1,500 per acre was used for land above the present site and an average value of $2,000 per acre for land below the present site. These high land costs reflect the presence of coal beneath the surface.

Table 21. Tongue River Project--construction and engineering cost estimates (in 1980 dollars).

	NEW HIGH TONGUE RIVER DAM Mine coal in enlarged and existing reservoir		NEW HIGH TONGUE RIVER DAM Mine coal in existing reservoir		NEW MIDDLE TONGUE RIVER DAM (POST CREEK SITE)	
Water Storage Elevation (feet)	3,438		3,438		3,438	
Emergency Spillway Crest Elevation (feet)	3,424.4		N/A		N/A	
Flood Pool Elevation (feet)	3,446.6		3,446.6		3,446.6	
Reservoir Area, Storage (acres)	7,700		7,700		6,500	
Reservoir Area, Flood Pool (acres)	8,900		8,900		7,800	
Reservoir Capacity (acre-feet)	320,000		320,000		223,000	
	QUANTITY	ESTIMATED COST DOLLARS	QUANTITY	ESTIMATED COST DOLLARS	QUANTITY	ESTIMATED COST DOLLARS
DAM EMBANKMENT						
Excavation dam foundation, drains, cutoff, and outlet works	2,982,000 cu.yds.	$ 12,116,000	2,982,000 cu.yds.	$ 12,116,000	2,370,000 cu.yds.	$ 9,375,000
Embankment fill incl. blankets	9,203,000 cu.yds.	22,052,000	9,203,000 cu.yds.	22,052,000	6,489,000 cu.yds.	15,964,000
Drilling & grouting	Lump Sum	2,647,000	Lump Sum	2,647,000	Lump Sum	5,816,000
Instrumentation	Lump Sum	247,000	Lump Sum	247,000	Lump Sum	247,000
Subtotal Dam Embankment		$ 37,062,000		$ 37,062,000		$ 31,402,000
SPILLWAY						
Excavation and backfill	7,790,000 cu.yds.	$ 24,827,000	7,790,000 cu.yds.	$ 24,827,000	2,136,000 cu.yds.	$ 7,027,000
Concrete incl. cement, re-steel, waterstops an included items	152,000 cu.yds.	41,940,000	152,000 cu.yds.	41,940,000	142,000 cu.yds.	39,028,000
Drains	11,500 feet	1,600,000	11,500 feet	1,600,000	12,450 feet	1,236,000
Bridge	Lump Sum	1,178,000	Lump Sum	1,178,000	Lump Sum	1,179,000
Gates	Lump Sum	4,391,000	Lump Sum	4,391,000	Lump Sum	4,394,000
Subtotal Spillway		$ 73,936,000		$ 73,936,000		$ 52,864,000
OUTLET WORKS						
Concrete incl. cement, re-steel, waterstops and included items	24,800 cu.yds.	$ 6,287,000	24,800 cu.yds.	$ 6,287,000	18,200 cu.yds.	$ 5,080,000
Steel conduit	1,795,000 lbs.	3,155,000	1,795,000 lbs.	3,155,000	1,275,700 lbs.	2,243,000
Outlet valves and operating system	Lump Sum	945,000	Lump Sum	945,000	Lump Sum	946,000
Air inlet pipe, manifold and bridge	-0-	-0-	-0-	-0-	-0-	-0-
Bypass pumping	-0-	-0-	-0-	-0-	-0-	-0-
Subtotal Outlet Works		$ 10,387,000		$ 10,387,000		$ 8,269,000
ROADS AND SITE WORK						
Road relocation	1.4 miles	$ 616,000	1.4 miles	$ 616,000	5.8 miles	$ 2,553,000
Road improvement	7.3 miles	1,286,000	7.3 miles	1,286,000	7.3 miles	1,287,000
Site work (includes breaching existing dam)		2,846,000		$ 2,846,000		2,863,000
		$ 4,748,000		$ 4,748,000		$ 6,703,000
COMPARATIVE TOTAL PROJECT CONSTRUCTION ESTIMATE		$126,133,000		$126,133,000		$ 99,238,000
ALLOWANCE FOR CONTINGENCIES		$ 25,227,000		$ 25,227,000		$ 34,733,000
ENGINEERING						
Geotechnical investigation and surveying		$ 314,000		$ 314,000		$ 1,013,000
Design engineering, plans and specifications		3,217,000		3,217,000		3,771,000
Engineering during construction, management of construction		9,681,000		9,681,000		8,237,000
Subtotal Engineering		$ 13,212,000		$ 13,212,000		$ 13,021,000
HYDROELECTRIC PLANT AND OTHER ITEMS	Hydroelectric Plant*	$ 6,327,000	Hydroelectric Plant*	6,327,000		$ 4,515,000
	Emergency Spillway**	24,264,000		-0-		-0-
COMPARATIVE TOTAL PROJECT ESTIMATE		$195,168,000		$170,899,000		$151,507,000

Additional items not included which must be added to this estimate include land and land rights, State of Montana administrative costs, environmental investigations and reports, interest and cost of financing and escalation to beginning of project.

* Hydroelectric plant includes construction, engineering and contingency. Enlarging the present Tongue River Reservoir without mining, enlarging the present Tongue River Reservoir with mining and replacing the spillway at the present Tongue River Dam include modification of outlet works.

** Emergency spillway to be built as soon as permits are obtained. Cost includes construction, engineering and contingency.

***Crest structure to be added at completion of mining. Cost includes construction, engineering and contingency.

Table 21 (continued). Tongue River Project--construction and engineering cost estimates (in 1980 dollars).

	REPAIR SPILLWAY OF EXISTING TONGUE RIVER DAM		ENLARGE EXISTING TONGUE RIVER DAM	
Water Storage Elevation (feet)	3,424.4		3,438	
Emergency Spillway Crest Elevation (feet)	3,427		3,455	
Flood Pool Elevation (feet)	3,445		3,471.5	
Reservoir Area, Storage (acres)	3,300		5,000	
Reservoir Area, Flood Pool (acres)	6,100		8,000	
Reservoir Capacity (acre-feet)	68,000		130,000	
	QUANTITY	ESTIMATED COST DOLLARS	QUANTITY	ESTIMATED COST DOLLARS
DAM EMBANKMENT				
Excavation of dam foundation, drains, cutoff, and outlet works	24,000 cu.yds.	$ 69,000	1,157,000 cu.yds.	$ 6,395,000
Embankment fill incl. blankets	153,000 cu.yds.	371,000	2,294,000 cu.yds.	5,397,000
Drilling and grouting or slurry trench	Lump Sum	2,993,000	Lump Sum	246,000
Instrumentation	Lump Sum	226,000	Lump Sum	237,000
Subtotal--Dam Embankment		$ 3,659,000		$12,275,000
SERVICE SPILLWAY				
Excavation and backfill	950,000 cu.yds.	$ 5,218,000	3,381,000 cu.yds.	$10,205,000
Concrete incl. cement, re-steel, waterstops and included items	20,500 cu.yds.	13,131,000	46,900 cu.yds.	13,042,000
Drains	3,200 feet	444,000	6,600 feet	1,006,000
Bridge	-0-	-0-	-0-	-0-
Consolidation Grouting	Lump Sum	1,352,000	-0-	-0-
Subtotal--Service Spillway		$20,185,000		$24,253,000
EMERGENCY SPILLWAY				
Excavation	4,432,000 cu.yds.	$15,290,000	1,035,000 cu.yds.	$ 3,115,000
Concrete incl. cement, re-steel	20,300 cu.yds.	4,734,000	8,800 cu.yds.	2,431,000
Subtotal--Emergency Spillway		$20,024,000		$ 5,546,000
OUTLET WORKS				
Concrete incl. cement, re-steel, waterstops and included items	55 cu.yds.	$ 24,000	400 cu.yds.	$ 714,000
Air inlet pipe, manifold and bridge	-0-	-0-	Lump Sum	101,000
Bypass pumping	-0-	-0-	Lump Sum	424,000
Subtotal--Outlet Works		$ 24,000		$ 1,239,000
ROADS AND SITE WORK				
Site work	Lump Sum	$ 27,000	Lump Sum	$ 33,000
Road relocation	-0-	-0-	5.5 miles	2,322,000
Road improvement	-0-	-0-	1.7 miles	287,000
Subtotal--Roads and Site Work		$ 27,000		$ 2,642,000
COMPARATIVE TOTAL PROJECT CONSTRUCTION ESTIMATE		$43,919,000		$45,955,000
ALLOWANCE FOR CONTINGENCIES		$10,979,000		$11,489,000
ENGINEERING				
Geotechnical investigation and surveying		$ 578,000		$ 578,000
Design engineering, plans and specifications		1,419,000		1,486,000
Engineering during construction, management of construction		3,520,000		3,684,000
Subtotal--Engineering		$ 5,517,000		$ 5,748,000
HYDROELECTRIC PLANT AND OTHER ITEMS	Hydroelectric Plant*	$ 6,105,000	Hydroelectric Plant*	$ 7,116,000
COMPARATIVE TOTAL PROJECT ESTIMATE		$66,520,000		$70,308,000

Table 21 (continued). Tongue River Project--construction and engineering cost estimates (in 1980 dollars).

	ENLARGE EXISTING TONGUE RIVER DAM Mine coal in existing reservoir		REPLACE SPILLWAY OF EXISTING TONGUE RIVER DAM Mine coal in existing reservoir		BREACH TONGUE RIVER DAM	
Water Storage Elevation (feet)	3,438		3,424.4		-----	
Emergency Spillway Crest Elevation (feet)	N/A		N/A		-----	
Flood Pool Elevation (feet)	3,446.6		3,455		-----	
Reservoir Area, Storage (acres)	5,000		3,300		-----	
Reservoir Area, Flood Pool (acres)	6,000		7,300		-----	
Reservoir Capacity (acre-feet)	130,000		68,000		-----	
	QUANTITY	ESTIMATED COST DOLLARS	QUANTITY	ESTIMATED COST DOLLARS	QUANTITY	ESTIMATED COST DOLLARS
DAM EMBANKMENT						
Excavation dam foundation, drains cutoff, and outlet works	979,000 cu.yds.	$ 6,054,000	616,000 cu.yds.	$ 3,889,000	418,000 cu.yds.	$2,777,000
Embankment fill incl. blankets	1,373,000 cu.yds.	3,236,000	1,238,000 cu.yds.	2,914,000	-0-	-0-
Drilling & grouting	Lump Sum	246,000	Lump Sum	412,000	-0-	-0-
Instrumentation	Lump Sum	237,000	Lump Sum	237,000	-0-	-0-
Subtotal Dam Embankment		$ 9,773,000		$ 7,452,000		$2,777,000
SPILLWAY						
Excavation and backfill	5,625,000 cu.yds.	$ 17,227,000	5,110,000 cu.yds.	$ 15,505,000	-0-	-0-
Concrete incl. cement, re-steel, waterstops and included items	123,000 cy.yds.	34,366,000	113,000 cu.yds.	34,521,000	-0-	-0-
Drains	3,500 feet	674,000	7,100 feet	1,010,000	-0-	-0-
Bridge	Lump Sum	1,131,000	Lump Sum	1,889,000	-0-	-0-
Gates	Lump Sum	4,214,000	-0-	-0-	-0-	-0-
Subtotal Spillway		$ 57,612,000		$ 52,925,000		-0-
OUTLET WORKS						
Concrete incl. cement, re-steel, waterstops and included items	150 cu.yds.	$ 199,000	50 cu.yds.	$ 23,000	500 cu.yds.	$ 133,000
Steel conduit	-0-	-0-	-0-	-0-	-0-	-0-
Outlet valves and operating system	-0-	-0-	-0-	-0-	-0-	-0-
Air inlet pipe, manifold and bridge	Lump Sum	101,000	Lump Sum	101,000	-0-	-0-
Bypass pumping	Lump Sum	424,000	Lump Sum	424,000	-0-	-0-
Subtotal Outlet Works		$ 724,000		$ 548,000		$ 133,000
ROADS AND SITE WORK						
Road relocation	5.5 miles	$ 2,322,000	5.5 miles	$ 2,322,000	-0-	-0-
Road improvement	1.7 miles	287,000	1.7 miles	287,000	-0-	-0-
Site work (includes breaching existing dam)	Lump Sum	33,000	Lump Sum	27,000	Hydromulch 3,300 Ac.	3,945,000
		$ 2,642,000		$ 2,636,000		$3,945,000
COMPARATIVE TOTAL PROJECT CONSTRUCTION ESTIMATE		$ 70,751,000		$ 63,561,000		$6,855,000
ALLOWANCE FOR CONTINGENCIES		$ 17,688,000		$ 15,890,000		$1,714,000
ENGINEERING						
Geotechnical investigation and surveying		$ 578,000		$ 578,000		$ -0-
Design engineering, plans and specification		2,005,000		1,973,000		202,000
Engineering during construction, management of construction		5,530,000		4,979,000		540,000
Subtotal Engineering		$ 8,113,000		$ 7,530,000		$ 742,000
HYDROELECTRIC PLANT AND OTHER ITEMS Hydroelectric Plant*		7,116,000	Hydroelectric Plant*	6,105,000		-0-
		-0-	Crest Structure***	8,057,000		-0-
COMPARATIVE TOTAL PROJECT ESTIMATE		$103,668,000		$101,143,000		$9,311,000

5. Financing

Project costs are generally not matched either in amount or timing with project revenue. Basically, the project must be built before it can generate any revenues. Thus, project costs are covered by other funds. Generally, long-term bonds are issued at the beginning of the project with maturities that extend beyond completion of the project. The interest on these bonds constitutes the major financing cost. Other financing costs include such items as insurance and underwriter's discount.

The interest rate on bonds depends upon the tax status of the bond issue. Tax exempt bonds have a lower interest rate than taxable bonds. Since the Tongue River Project would be a public project, the interest would, therefore, be tax-exempt and lower than a similar taxable bond issue. The risk to the bond purchasers also has a bearing on the interest rate of the bonds. For example, bonds backed by the general repayment of the state would pose a smaller risk than bonds backed by the revenue from the project. Of course, the total financing costs would be related to the size of the bond issue. Those alternatives having larger project costs would be associated with larger financing costs.

6. Operation, Maintenance, and Repair

After the project is constructed and operation begins, there will be costs associated with the operation, maintenance, and repair (OMR). The larger and more mechanical alternatives will require larger support personnel and higher maintenance and repair costs. The OMR costs for the project are estimated at 6 percent of the construction costs. The OMR costs for the hydroelectric plant were taken from figures suggested by the Federal Energy Regulatory Commission.

D. GOAL SATISFACTION

1. Breaching the Dam

This alternative would eliminate the unsafe condition of the project (DNRC's principal objective) by eliminating the project. On the other hand, all project benefits would be lost. Thus, the second objective would not be met. The Indian/non-Indian water rights conflicts would not be resolved by this alternative either and so the third objective would not be met. The cost of breaching the dam could be significantly offset by sale of the land under the reservoir. Coal revenue would probably not occur under this alternative because the reservoir area would be returned to its orginal state as an alluvial valley and it is doubtful that mining in an alluvial valley would be permitted. The loss of existing project benefits and of the vehicle for solving the Indian/non-Indian water rights conflict would make this alternative undesirable.

2. Building a Larger Spillway at the Existing Dam (Repair Alternative)

This alternative would satisfy the principal objective by providing for the passage of the PMF thereby making the project safe. The second objective would also be met because this alternative would preserve the existing project benefits and could increase the firm water supply by possibly 12,000 acre-feet per year. As previously mentioned, this increase would be possible (even though the total capacity of the reservoir would remain unchanged) because the reservoir could be more fully used with a larger spillway in place.

It is doubtful, however, that this small increase in the firm water supply would be sufficient to meet all future water demands, including resolution of the Indian/non-Indian water rights conflict. Consequently, the third objective would not be met.

Likewise, the least-cost objective could not be satisfied by this alternative, since without industrial water sales, project costs would be much larger than project revenues. Revenue from hydropower at best does little more than repay the cost of installing the hydroelectric facilities. Revenue generated from mining DNRC-owned coal under the existing reservoir would be substantial. However, this would be offset by the more expensive gated spillway.

3. Raising the Existing Dam (Enlarging Alternative)

Raising the existing dam would result in a safe project that would preserve the present project's benefits and that would more than double the firm annual yield. Thus the first two objectives are satisfied.

The Northern Cheyenne Tribe has indicated that it would be interested in this or other alternatives that would substantially increase the water supply. The tribe is evaluating each alternative project that would increase the water supply to determine which project best meets its present and future needs. This alternative, therefore, may lead to a resolution of the Indian/non-Indian water right conflict, thereby satisfying the third project objective.

Project revenues would not repay project costs unless industrial customers could be found. As with the repair alternative, hydropower would provide little revenue and, in the mining option hydropower revenue would be unlikely to repay the cost of installation. Similarly, coal mining revenues to DNRC would be substantial, about $39 million, but would increase project costs.

DNRC believes, however, that this project could possibly be built at minimal cost to the state, since it appears to have a good chance for federal participation. This would provide a means of getting a congressional appropriation to fund a substantial portion of project construction. This appears to be justified if the project would be a joint state/federal/Northern Cheyenne Tribe project. The federal government would, through the Bureau of Indian Affairs and the Northern Cheyenne Tribe, finance a portion of project construction. DNRC would contribute existing project assets, water rights, and planning efforts to the project while as well being possibly required to share project construction costs. Project water sold by DNRC would at least partially offset the DNRC cost share. It may be, however, that the state would give up sole ownership of the project.

4. The Post Creek Site

This alternative, like the enlarging alternative, satisfies the first three project objectives.

This alternative, however, does not appear economically attractive. Unless a large new industrial water market appears, project revenues would not be sufficient to pay for the project. Revenue generated by hydropower would do little more than pay for installation of the power plant. Revenue from coal leasing would bring in about $39 million but this alternative is substantially more expensive than the previously considered alternatives. The likelihood of a congressional appropriation for this alternative appears less than for the enlarging alternative, because of the large dependence on new industrial water sales.

5. The High Tongue Dam Site

Both options at the high Tongue dam site would meet the first three objectives through construction of a safe project and the substantial increase in water supply. Like the Post Creek site, however, this alternative relies heavily on new industrial water sales to offset project costs. The lack of a ready industrial market, therefore, significantly reduces the financial attractiveness of this alternative.

Although hydropower and coal lease revenues appear to be substantial for both options, the increase in project cost over those alternatives at the existing site are much larger.

As with the Post Creek site, federal involvement looks less promising than for the enlarging alternative.

5. FINANCING METHODS

Four sources of revenue associated with the Tongue River Project were discussed in the previous chapter. These sources include:

1. water sales, both current and future, to agriculture and industry in all alternatives except breaching;
2. hydroelectric sales in all alternatives except breaching;
3. coal revenues--from surface and/or mineral right leases and severance and resource indemnity taxes--in all alternatives contemplating coal mining; and
4. land sales in the breaching alternative only, where sale of the land currently under the reservoir could produce revenue.

The nature of the alternatives considered and the magnitude and timing of construction costs preclude reliance solely on project-generated revenues. In addition, since these revenues cannot meet project costs, external funding sources would be required.

Two external sources of revenue were considered. These were severance tax bonding, through the Water Development Program, and federal assistance through a joint state/federal/Northern Cheyenne Tribe project wherein the federal government as trustee of the tribe would contribute to the project financially.

A. SEVERANCE TAX BONDING

1. Water Development Program

The Forty-Seventh Legislature created the Water Development Program with the passage of Senate Bill 409. The program allows the State of Montana to issue bonds backed by coal severance tax revenues to finance water projects, economic development projects, and other capital improvements such as the Tongue River Project.

To be financed with severance tax bonds, however, a project must be approved by a three-fourths majority of each house of the legislature. After this approval, the Board of Examiners issues bonds and the proceeds of the bond sale finance the project.

Under the Water Development Program, project revenues and severance tax receipts, to the extent required, are used to pay principal and interest payments to retire coal severance tax bonds. This mechanism for paying debt service on the bonds with coal severance tax proceeds before they are deposited into the permanent trust fund is a part of the Water Development Program. Senate Bill 409 divided the constitutional trust fund, which receives 50 percent

of the gross proceeds of the coal severance tax, into three subfunds: a bond subfund, a permanent subfund, and an income subfund. Severance tax revenue is first deposited in the bond subfund. Principal and interest payments not covered by project revenues are paid from the bond subfund. Funds remaining in the bond subfund are then transferred on June 30 and December 31 of each year to the permanent fund and invested in securities. Earnings from investments are deposited to the income subfund and are available for appropriation by the legislature. Senate Bill 409 also contained a provision which allows the legislature to appropriate up to 15 percent of the trust's investment earnings for redeposit into the permanent subfund to supplement the permanent trust when coal severance tax bonds are issued.

The total amount of coal severance tax bonds which the legislature may authorize is limited in two ways: (1) the legislature may authorize no more than $250 million in coal severance tax bonds, and (2) the amount of bonds issued may not have outstanding annual debt service costs exceeding two-thirds of the average of three previous years of coal severance tax proceeds deposited to the bond subfund.

2. State Project

The derivation of bonding requirements, their computations as well as a financing plan and cash flow analysis for each of the alternatives are explained in The Appendixes to the Tongue River Rehabilitation Project under a separate cover.

The Water Development Program provides a mechanism that could use severance tax bonds to provide a totally state-financed project. Table 22 summarizes the financing for each alternative under this program. Column 1 in table 22 shows total project costs which is the sum of the estimated cost of each cost item plus an adjustment to account for inflation. Column 2 shows the estimated 1980-dollar construction and engineering cost, and column 3 shows the size and projected date of each bond issue. The remaining columns display the net present value of project revenues discounted at 10 percent for four situations:

1. The project receives no new water sales and the severance tax on project-related coal is not applied to the project (column 4);
2. The project receives new water sales but the severance tax on project-related coal is not applied to the project (column 5);
3. The project receives no new water sales but the severance tax on project-related coal is applied to the project (column 6); and
4. The project receives new water sales and the severance tax on project-related coal is applied to the project (column 7).

Similar analyses using 5 percent and 20 percent discount rates are shown for each alternative under "Financial and Economic Analysis" in The Appendixes to the Tongue River Rehabilitation Project, under another cover. As table 22 shows, the net present value of project revenue can be positive or negative. For instance, the first alternative, building the high Tongue dam and mining both the present reservoir and the area between the present and high Tongue dam sites, can be the greatest money maker (if the assumptions of column 7 are realized) or the greatest money loser (if the assumptions of column 4 are realized).

The figures in columns 4, 5, 6 and 7 indicate the degree to which an alternative depends on new water sales or application of project-related severance taxes. Using the first alternative as an example again, the table shows the alternative's success hinges more on application of project-related severance taxes than on new water sales by the larger increase in the net present value of revenue due to severance tax than due to water sales. On the other hand, the fifth alternative, enlarging the present Tongue River Project without mining coal, shows no increase due to application of project-related severance tax (because there would be none) and only a modest increase due to new water sales.

Table 22 also shows that new water sales alone would be able to pay project costs for only the first and second alternatives. Of the alternatives contemplating coal mining (the first, second, third, fourth and sixth), application of project-related coal severance taxes would produce a positive net present value in all cases except the second alternative. The no-mining alternatives (the fifth and seventh) and the breaching alternative show negative net present values both with and without new water sales.

Table 22. Summary of severance tax bonding (Water Development Program) mechanism for all alternatives (in thousands of dollars).

	1	2	3		4	5	6	7
					Net Present Value of Project Revenue at 10 Percent Discount			
			Bond Issues					
Alternative	Total Project Costs*	Construction and Engineering Cost (1980 dollars)	Bond Amounts	Projected Date of Issuance	Without New Water Sales; Without Severance Tax	With New Water Sales; Without Severance Tax	Without New Water Sales; With Severance Tax	With New Water Sales; With Severance Tax
1. New High Tongue Dam, Mine Coal Downstream and in Existing Reservoir	$876,654	$195,163	$ 44,810	1/1/83	-$115,970	$31,244	$63,925	$211,140
			16,015	1/1/92				
			408,150	1/1/98				
			440,165	1/1/00				
			Total $909,130					
2. New High Tongue Dam, Mine Coal in Existing Reservoir	$304,905	$170,899	$ 16,855	1/1/83	-$102,485	$35,777	-$24,489	$113,773
			273,810	1/1/86				
			Total 290,665					
3. New Post Creek Dam, Mine Coal in Existing Reservoir	$265,723	$151,507	$ 13,580	1/1/83	-$88,284	-$37,383	-$10,289	$ 40,613
			238,780	1/1/86				
			Total $252,360					
4. Enlarge Existing Tongue River Reservoir, Mine Coal in Existing Reservoir	$188,930	$103,668	$110,755	1/1/83	-$53,537	-$52,917	$24,454	$ 25,073
			23,985	1/1/99				
			Total $134,740					
5. Enlarge Existing Tongue River Reservoir, No Mining	$119,617	$ 70,308	$ 90,740	1/1/83	-$45,650	-$44,955	-$45,650	-$44,955
6. Replace Spillway at Existing Tongue River Dam, Mine Coal in Existing Reservoir	$135,069	$101,143	$111,680	1/1/83	-$52,942	-$52,942	$25,054	$ 25,054
			17,865	1/1/99				
			Total $129,545					
7. Repair Spillway at Existing Tongue River Dam, No Mining	$ 84,292	$ 66,520	$ 85,700	1/1/83	-$40,168	-$40,168	-$40,168	-$40,168
8. Breach Tongue River Dam	$ 12,946	$ 9,311**	$ 15,035	1/1/84	-$ 2,235	-$ 2,235	-$ 2,235	-$ 2,235

* Costs inflated to reflect estimated time of disbursement
** Cost of breaching

B. FEDERAL ASSISTANCE

1. Possibility of Federal Financing

Because it would reduce the financial burden on the residents of the state, federal assistance was considered to be an important source of funds for the project.

Federal funding relative to project development and construction costs would require a congressional appropriation. However, in the current environment of reductions in all areas of government spending, this particular funding vehicle may impose a significant degree of uncertainty for timely project financing. Additionally, federal funding would require federally acceptable cost-benefit analysis. This may require the state to develop industrial water sales contracts to assure the federal government of repayment or make direct payments to the federal government in lieu of water sales contracts. Much of the work that would be necessary to prepare a proposal for federal funding would also be necessary for developing the project generally. Thus, in view of the possibility of low cost federal funds, it is considered prudent to thoroughly explore this approach before turning to another.

Federal funding for the project is currently being sought. DNRC initiated discussions with the Northern Cheyenne Tribe, the Bureau of Indian Affairs and other state and federal agencies to investigate the possibility of partial federal funding. Through the participation of the Northern Cheyenne Tribe and the federal government, congress may be able to fund a substantial portion of the project through appropriation. However, in all likelihood, only those alternatives that substantially increase the stored water supply (i.e., satisfy the Indian water rights dispute) would be given consideration. This probably removes the repair alternatives at the existing site from consideration because they provide too little of an increase in stored water. The enlarge alternatives at the existing site may increase the water supply sufficiently, as do the alternatives at the new sites.

Congress, were it to appropriate funds for the project, would probably require the state to share the costs. The magnitude of state cost sharing is uncertain at this time. If the state cost share were a relatively small amount, the state legislature might simply appropriate funds from available state resources. If it were a substantial amount, however, tax-exempt bonds issued under the Water Development Program would be the preferable vehicle for effecting the state's share of funding.

2. Financing Mechanism

The financing mechanism could be based on joint ownership of the project with each co-owner jointly controlling the water. The State of Montana would contribute the present project (i.e. the present structures and land) plus a part of the construction costs. The remainder of project costs would be provided by congress on behalf of the tribe, via the Bureau of Indian Affairs, and the federal government, via the Bureau of Reclamation.

Financial analyses of federal projects classify benefits as either reimbursable or nonreimbursable. The creation of a water supply is generally considered a reimbursable benefit since this benefit can be marketed, whereas recreation and

flood control benefits are nonreimbursable. The attractiveness of federal financing may be enhanced by the consideration of the benefits associated with the removal of the safety problem, as being a nonreimbursable. This is currently unprecedented, and with the reduction of government spending it may not be too probable at this time.

The revenue from water (agricultural and industrial) and hydropower sales, at least in the near future, would probably be insufficient to cover the value of reimbursable benefits.

For the enlarge alternative at the existing site, the tribal settlement will probably constitute most of the additional water. Any water in addition to the present firm annual yield (40,000 acre-feet) and the tribal settlement made available by the project could then be sold. This water may have to be allocated to industrial use rather than agricultural use to receive sufficient revenue because of the lower prices agricultural users could pay.

3. Implementation

Any federally financed project would have three basic phases: prefeasibility study activities, feasibility study and EIS preparation, and construction authorization and appropriation.

The prefeasibility study activities are primarily concerned with the reduction of the number of possible alternatives, and securing funding for the feasibility and EIS studies. The activities that would be used to narrow down the alternatives include review of previous studies, site review, formulation (water allocations), and economic considerations.

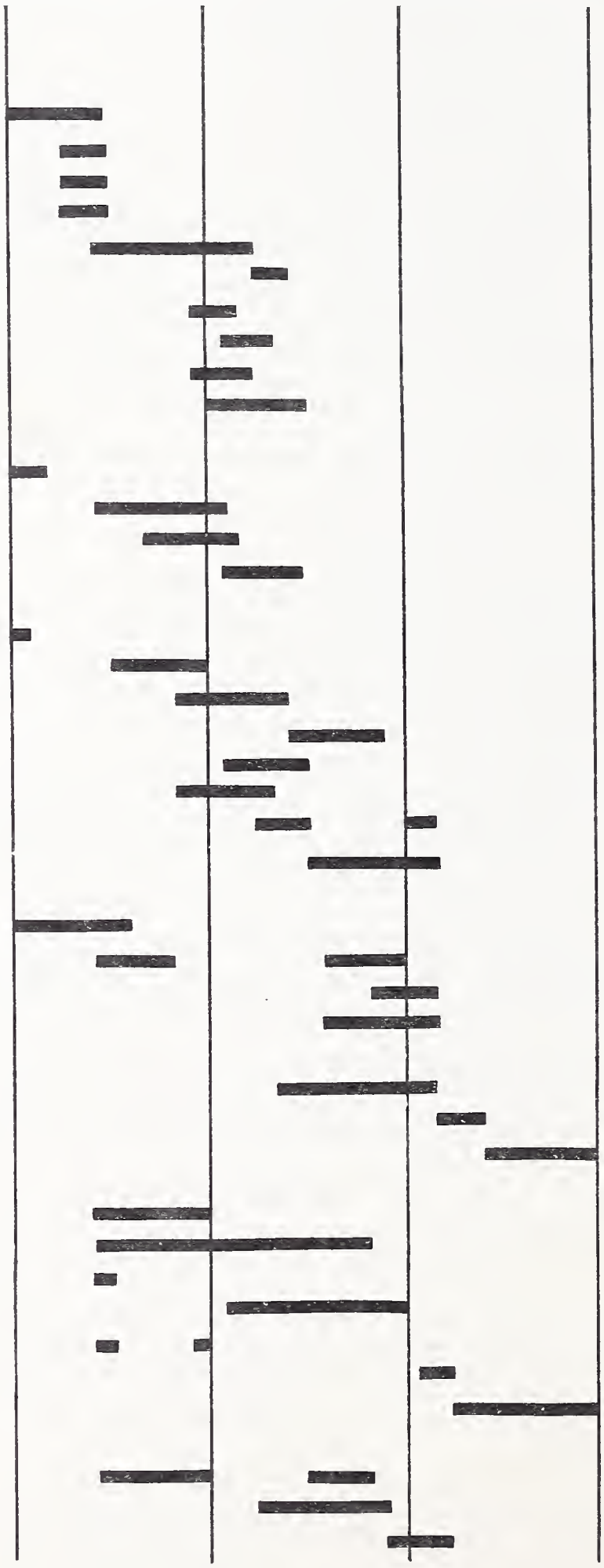
Previous studies, including the present DNRC work, have addressed numerous alternatives. The criteria used in generating these alternatives would need review. Similarly, the criteria used in comparing the various alternatives would also be reviewed by federal agencies. This review would help establish a set of criteria and assumptions for selecting acceptable alternatives. The result would be several alternatives at various sites. Most likely, the three sites identified by DNRC would be used. However, the site review would investigate the area to locate other possible sites.

The formulation activity would involve the distribution of water for each alternative. Allocations would be proposed that divide the firm annual yield between tribal and nontribal users and between agriculture, industry, and instream flow. Review of the proposed allocation schemes would insure that they would be agreeable to all users and interested parties. In all cases, however, competing interests may have to compromise. The end results of this compromise would form an important part of the tribe's water rights compact.

The activities associated with the appraisal estimates would focus on the economics of the alternatives and water allocation schemes. The costs and benefits of each would be assessed. This task would substantially reduce the number of alternatives and water allocation schemes--probably down to two or three options.

Concurrently with these activities, a congressional appropriation would be sought for funding of the feasibility and EIS studies. There are two routes for the federal appropriation: directly to Bureau of Reclamation or tentatively to Bureau of Indian Affairs, and then contracted to the Bureau of Reclamation. The

Table 23. Feasibility and EIS-study schedule for the Tongue River Project.



Feasibility Study
- Hydrology
  - Water Supply
    - Irrigation
    - M & I
    - Power Generation
  - Design Storm
  - Inflow Design
  - Sedimentation
  - Tailwater
  - Canal & Lateral Sizing
  - Appendix
- Soils
  - Review
  - Classification
  - Drainage
  - Appendix
- Geology and Engineering
  - Site Review
  - Drilling
  - Design Package, Dam & Powerplant
  - Design Dam & Powerplant
  - Design Irrigation
  - Field Surveys
  - OM & R
  - Appendix
- Economics
  - Farm Budget
  - Social Assessment
  - Economic Analysis
  - Appendix
- Report
  - Write
  - Participant Review
  - Review Process

Environmental Impact Statement
- Data Collection
- Archeology Study
- Scoping Session
- Write EIS
- Endangered Species (Sec 7)
- Participant Review
- Review Process

Coordination Report (USF&WS)*
- Data Collection
- Draft Report
- Final Report

* US Fish & Wildlife Service

Bureau would then complete these studies. Either route would require congressional authorization. The previous aspects, along with political concerns, would determine the preferred alternative. Congressional hearings on the authorization and appropriation would require an indication from Bureau of Indian Affairs and Bureau of Reclamation that they would have the capability to participate in the studies and utilize the funding.

The initiation of the feasibility study would be contingent on the narrowing of the options for consideration to a maximum of two which would be, in turn, contingent on an agreement as to the allocation of water with the tribe.

For enlargement at the present site, federal feasibility and EIS studies should take three years to complete. Table 23 lists the major elements of the studies and their schedule. The feasibility study concentrates on the engineering and economic feasibility of the project. The EIS focuses on the impacts to the aquatic and terrestial habitat and any historical or archeological sites.

The feasibility and EIS studies would be used to secure congressional authorization and appropriation for construction. The construction activities and schedule should be generally similar to those previously described for each alternative.

6. RECOMMENDED PROJECT

A. PROJECT DESCRIPTION

The preferred alternative is enlarging the project at the existing site, the no-mining option. The features would include a new service spillway capable of handling 194,000 cfs and an earthen spillway which would be activated for floods greater than about 70,100 cfs. The service spillway crest elevation would be 3,438 ft MSL, which would increase the reservoir elevation by 14 feet and increase the firm annual yield from about 40,000 acre-feet to 82,000 acre-feet.

The earthen spillway crest elevation would be 3,455 ft MSL. Thus, there would be 17 feet of water flowing through the service spillway before the earthen spillway would be activated. Together, the two spillways would accommodate the PMF.

The existing spillway would be removed and the area filled in, making it part of the embankment. The existing outlet works would be repaired and modified to feed into the hydroelectric plant. The embankment would be raised to 3,475 ft MSL and flood pool elevation--assuming a PMF--would be 3,471.5 ft MSL.

Although the normal water surface elevation, 3,438 ft MSL, would not back water into Wyoming or inundate the West Decker and East Decker railroad spurs, during a flood situation, water could overtop the railroad beds and back into Wyoming. The highway bridge crossing the Tongue River just above the reservoir is at an approximate elevation of 3,439 ft MSL and would obviously have to be raised.

B. PROJECT FINANCING

The preferred financing mechanism is the federal financing (i.e., a joint state/federal/Northern Cheyenne Tribe project). The state would contribute its project assets, such as the present structure, land, and water contracts, and a cost share. The federal government would, on behalf of the tribe, contribute the remaining funds needed to construct the project.

Prior to the congressional authorization and appropriation to construct the project, the federal government would have to prepare a feasibility and EIS study of the preferred alternative. The federal government would also have to review the work done by DNRC to confirm that DNRC's preferred alternative would be consistent with federal guidelines. The funds required to do this work would be appropriated by Congress via a request by the Montana delegation.

The severance tax bond mechanism would provide a fall back plan in the event the federal financing mechanism does not provide the adequate funding.

C. SCHEDULE OF ACTIVITIES

There are basically six major tasks associated with the project: (1) review of past studies, (2) tribal water rights settlement, (3) feasibility and EIS studies, (4) congressional authorization and appropriation, (5) construction, and (6) reservoir filling. Table 24 shows the projected schedule for each of these major activities.

Table 24. Schedule of activities for the recommended project.

Fiscal Year	FY 81		FY 82				FY 83				FY 84				FY 85				FY 86				FY 87				FY 88				FY 89			
Quarter	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Review of past studies	X	X																																
Tribal water rights settlement	X	X	X	X																														
Feasibility and EIS studies			X	X	X	X	X	X	X	X	X	X	X	X																				
Congressional authorization and appropriation			X	X	X	X																												
State Contribution					X	X	X																											
Design and Construction							X	X	X	X	X	X	X	X	X	X	X	X																
Reservoir filling																											X	X	X	X	X	X		

The Bureau of Reclamation would review past studies to satisfy the federal government that enlarging at the present site conforms to federal criteria. This would include a site review and economic consideration.

The tribal water rights settlement would probably be the most critical task. The schedule and success of the project hinge on the timely resolution of a compact with the tribe. Without such a compact, the feasibility study could not be concluded, and there would be no plan on which congress could authorize the project and appropriate funds. The tribal settlement would involve an analysis of water allocation (between tribal and nontribal uses and between agriculture, instream and industry), operation studies, and economic appraisal estimates. The 12 months allocated to this task should be sufficient, given the progress the Reserved Water Rights Compact Commission and the Northern Cheyenne Tribe have already made.

The major aspects of the feasibility study would be hydrology, soils, geology and engineering, and economics. However, before the feasibility study could proceed very far, an acceptable water allocation between users must be available. The Bureau of Reclamation has suggested a three-year feasibility study period.

Concurrently with the feasibility study, an EIS would be prepared. The major aspects of the EIS would be project impact assessment, endangered species, and historical and archeological considerations. Due to the extensive data collection and environmental assessment that have previously been completed for the coal mines in the area, no additional time should be needed for the EIS above that already allocated for the feasibility study. In other words, the feasibility study and the EIS should be completed at approximately the same time.

The feasibility and EIS studies would be used to secure congressional authorization and appropriation which would have to precede construction. At that time, the state's share of construction costs would be needed. The work required in this phase would be scheduled to coincide with the completion of the feasibility and EIS task.

Construction includes the final engineering design, engineering during construction, and the actual construction of the spillways, embankment, and hydroplant facilities. All this should require three construction seasons.

With completion of construction, the project could become fully operational after two run-off periods of at least average intensity.

D. RECOMMENDED STATE PROCEDURES

DNRC plans to take the lead role and ultimate responsibility for coordinating the project. Before congressional authorization and appropriation for construction of the project can be sought, DNRC would have to see that the following three major tasks are accomplished.

1. DNRC would have to develop an acceptable water allocation from the reservoir for all users. This would require extensive involvement and coordination with the Northern Cheyenne Tribe and the Reserved Water Rights Compact Commission, as well as nontribal agricultural and fish, wildlife and recreational interests.
2. DNRC would have to see that feasibility and EIS studies were completed to support a congressional authorization and appropriation to construct the project. The feasibility study would address basic engineering design, and economics and other items listed in table 23. The EIS would be conducted to satisfy the requirements of the Montana Environmental Policy Act and the National Environmental Policy Act.
3. DNRC would have to develop, implement, and maintain emergency warning and downstream evacuation systems for residents living below the Tongue River Project. Care would have to be taken to ensure that no lives would be lost should the project fail prior to the construction of a safe structure.

A steering committee would be created consisting of representatives from the organizations having an interest in the Tongue River Project. This committee would provide advise on most aspects of the project to ensure that issues would be satisfactorily addressed and objectives met. The overall direction of the project would rest with DNRC, although the Bureau of Reclamation would take the lead in the technical aspects of the feasibility and EIS studies.

This project would require special coordination between state and federal agencies, the Northern Cheyenne Tribe, TRWUA, conservation districts, local governmental organizations, and special interest groups (e.g. Northern Plains Resource Council). DNRC would be responsible for such coordination.

The dimension of public involvement would be determined by the steering committee. However, the responsibility of public involvement would rest with DNRC.

1. Description of Activities and Schedule

DNRC would develop a study plan for each major task. In developing an acceptable water allocation for all users, DNRC would work with the Reserved Water Rights Compact Commission and the Northern Cheyenne Tribe to allocate stored water. An acceptable allocation would have to address the monetary obligations of all users and include the necessary compacts and contracts to insure that the allocation and monetary requirements would be legal and binding. Allocations would be proposed that divide the firm annual yield between tribal and nontribal users, and agriculture, industry, and instream flow. After all users, including current users (e.g., TRWUA, Northern Cheyenne Tribe) reach an agreeable water allocation scheme, it would be subjected to an economic and financial analysis. Those allocations having a satisfactory financial status would then be analyzed to evaluate the water availability. Operation studies would be performed to give a better idea of the actual water available under the various allocations. These studies could also indicate the "not so firm yield" that could be expected 80 to 90 percent of the time. Finally, an allocation scheme would then be selected based on the acceptability to all users and interested parties, the financial status, and the amount of water actually available.

The detailed analyses of the feasibility and EIS studies would require some sort of water allocation plan between the users. Thus, this plan should be completed as early as possible and no later than one year after the start of the feasibility and EIS studies. As soon as money can be appropriated, DNRC should begin to coordinate its work with the work being done by the Reserved Water Rights Compact Commission and the Northern Cheyenne Tribe to hasten an acceptable allocation. Work on this task is scheduled to begin in early 1981 and extend at least through the end of the year.

The Bureau of Reclamation would take the lead role in the technical aspects of the feasibility and EIS studies. The authorization and appropriation to conduct these studies would be sought from Congress via legislation presented by the Montana delegation. DNRC would assume the responsibility of securing the legislation. To initiate the feasibility and EIS studies by 1982, there must be authorization and appropriation during the present session of congress, so the Montana delegation must be encouraged to introduce the authorizing legislation and to request appropriation as soon as possible.

Adequate background materials (e.g., summary of previous reports, proposal to study, justification statement, and proposed legislation) would have to be made available to the Montana delegation. DNRC would assemble the necessary package of background material.

Congressional hearings on this proposed authorization and appropriation would require an indication from the Bureau of Indian Affairs, the US Fish and Wildlife Service and the Bureau of Reclamation that they have the capability to participate in the studies and utilize the requested funding.

Aside from the congressional legislation, DNRC would have to review the technical aspects of the feasibility study and ensure that the elements of the EIS study meet the requirements of the Montana Environmental Policy Act. DNRC would also be responsible for supplying the Bureau of Reclamation with most of the background technical information already available on the project. With the interest in coal mining in the Tongue River area, a number of EIS's have already been completed. Thus, the amount of additional information needed should be minimal.

Assuming the success of the congressional legislation, the feasibility and EIS studies should take three years starting in October, 1981. During this three-year period, DNRC would continue to take a leadership role for the project.

The emergency warning and downstream evacuation systems to protect the downstream residents will be contracted to an appropriate organization. However, DNRC will maintain responsibility for the development and operation of the system.

As a first step, DNRC will contact the Disaster and Emergency Services Division of the Department of Military Affairs. Once the planning is completed, the set-up phase could proceed. This phase would involve the acquisition of capital improvements such as communication equipment and sensory equipment for snowpack and water elevation. The set-up phase should be completed as soon as possible to lower the risk to loss of life posed by the present unsafe situation.

In addition to these major tasks, DNRC would have to work on legal considerations involving the current water contracts and the ownership and operation of the new joint project. As a part of these legal considerations, DNRC would test its ability to issue debt via severance tax bonds (the proposed method of raising the state's share of construction costs).

2. Budget

For DNRC to take the lead role in this joint project, DNRC requested and received a special appropriation from the legislature for preconstruction activities (i.e., the major tasks as outlined in the previous section) and the state's share of construction costs. This appropriation is needed to complete the work outlined above and to prepare the mechanism by which the cost-share could be implemented. Table 25 shows the budget for preconstruction activities for the 1982-1983 biennium. The state's share of construction costs has been estimated to be $10 million.

Federal support for preconstruction activities for the next three years ($750,000) would be allocated to the Bureau of Reclamation, the US Fish and Wildlife Service and the Bureau of Indian Affairs for work on the feasibility and EIS studies. These funds would be disbursed as follows: $550,000 to be shared by the Bureau of Reclamation and the US Fish and Wildlife Service and $200,000 to the Bureau of Indian Affairs. Over the three years, the funding would be allocated in this manner: FY 1982--$250,000, FY 1983--$400,000 and FY 1984--$100,000.

Table 25. Proposed State Tongue River Project Budget.

	Biennium ending June 30, 1981	Biennium ending June 30, 1983
Staff	$ 2,732	$140,556
Operations		31,775
Travel	500	39,500
Contracted Services		
Evacuation/Warning Plan	30,000	20,000
Legal (test case/resultant water contracts/operation)		40,000
Financial (Test case)		30,000
Environmental(Supplement to US Fish and Wildlife Service EIS)		40,000
Hydrology (Allocation)		15,000
Computer		10,000
Contracted Management (Systems Technology, Inc.)	7,500	
Contingencies (8 percent)		28,500
TOTAL	$40,732	$395,331

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